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Production Efficiency on New England Dairy Farms

V. Adjustments in Obtaining Dairy Herd Replacements

by

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Preface and Acknowledgements

THIS BULLETIN is the fifth in a series concerned with production efficiency on New England dairy farms. In the first bulletin, a preliminary appraisal was made of the important opportunities for reducing costs in dairying. In the second and third bulletins of the series, the economies of scale of operations and of the barn-finishing method of harvesting hay, respectively, were analyzed in greater detail. The fourth bulletin dealt with the efficient use of machinery and equipment on dairy farms. The present publication investigates the raising of dairy herd replacements from the standpoint of the best use of agricultural resources by individual dairymen and in the dairy economy.

The authors are indebted to the many farmers and Dairy Herd Improvement Association Supervisors who helped to supply the basic information used in the study. They also wish to acknowledge the use of New Hampshire Experiment Station Bulletin 302, a study of dairy herd replacement practices, written by Harold C. Grinnell, which provided much of the background information. They wish especially to acknowledge the assistance and critical appraisal received from the staff of the Agricultural Economics Department of the University of New Hampshire; and from C. W. Crickman and Merton S. Parsons, Production Economics Research Branch, Agricultural Research Service, United States Department of Agriculture, Washington, D. C. The authors are also indebted to the staff of the Dairy Department, University of New Hampshire, particularly Gunnar B. Olsson, C. Hilton Boynton, and Harry A. Keener for their help and assistance.

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Summary

New England agriculture is rapidly becoming more specialized. In the past, dairy farms in this region had many profitable alternative enterprises, such as potatoes, field crops, poultry, and other livestock. Modern machinery, improved production practices, and increased competition from other agricultural areas have gradually reduced the economic advantages of these supplementary enterprises on the dairy farm.

The trend toward specialization raises questions concerning the direction future specialization should take to achieve more economic utilization of resources on New England dairy farms. An adjustment opportunity, in which there is widespread interest, centers around whether a New England dairyman should raise or buy replacements for his dairy herd. In the last 10 years, not enough replacements have been produced in New England to fill the needs. Under what conditions does raising of dairy herd replacements represent the best use of individual farm resources and development of the dairy farm economy in New England?

Nature of the Study

In New England, it is often argued that for two reasons a program of raising all replacements for the dairy herd is superior to buying some or all replacements. First, purchased replacements are thought to be inferior to home-raised replacements so far as risk of disease, herd life, and milk production are concerned. The second traditional argument that favors a program of raising replacements is that it is cheaper than buying them.

The study reported here is directed primarily at developing information on the physical relationships involved in dairying and a method of using information about these relationships in making economic decisions on how best to provide dairy herd replacements. A dairyman needs to decide how he can best use his roughage, his barn space, his labor, and his other production facilities to achieve maximum income in view of his costs of production, the price of purchased replacements, and the price of milk.

Feeding Rates for Young Stock and Cows

The feed inputs for producing home-raised replacements used in the economic analysis were those quantities of forage and concentrates that are typically fed to calves and young cattle on the sample of New Hampshire dairy farms surveyed in the study reported here. Feeding rates for cows were based on physical relationships observed under controlled feeding experiments. Records obtained in the farm survey indicate that they are representative of the level of feeding on New Hampshire dairy farms.

Milk Production Rates — Raised and Purchased Cows

Raised and purchased cows produce about the same amount of milk and therefore are comparable in terms of quality. This is based on a sample of cows with such factors as breed, date of freshening, management, fat content, and age eliminated.

Calves Born per Cow, Mortality, Sex Ratios, and Sterility Rates

Mortality and culling rates for young stock were established on farms operating under good management. If all potentially fertile female calves were raised for replacements, cow numbers could be increased at the annual rate of about 100 per 1,000 cows. Considering the annual rate of increase from the viewpoint of possibilities for culling and herd improvement, it would be possible to maintain a stable cow population and to cull about 100 replacements per 1,000 cows annually.

Incidence of Disease, Herd Life, Age at Disposal, and Life Expectancy

Purchased cows are no more prone to disease than raised cows. Of herd removals of purchased cows, 43 percent were removed for reasons of sterility, brucellosis, and udder trouble. Of the raised cows that were culled, 40 percent were removed for the same reasons. A study of a group of herds, some composed of all raised cows and some composed of raised and purchased cows, indicated that the number of removals because of disease was not disproportionate between the two types. On farms with all raised cows, 41 percent of the culled cows were removed because of udder trouble, sterility, and brucellosis. On farms with some purchased animals, 37 per cent of the culled cows were removed for these reasons.

Purchased cows have a longer total productive life than raised cows. The average age of disposal for nondairy purposes for purchased cows was 7.06 years, while that of cows raised on the farm was 5.74 years.

The life expectancy of dairy cows decreases gradually with the increase in age. This gradual decrease helps to explain the longer herd life of purchased cows. The life expectancy of New Hampshire dairy cows compares favorably with that estimated for cows in other areas of the United States.

Yields for Hay, Silage Crops, and Pasture

A careful study of the farm records for sample dairy farms reveals that differences in yields among crops were closely associated with management ability, the price of livestock, and supplies of feed. Both per acre yields and total tons of hay equivalent harvested were larger for farmers who did not buy replacements than for farmers who bought some of their replacements. Total forage consumed per animal unit was 5.2 tons per year on the farms with no purchased replacements and 5.8 tons on the farms whose operators bought some replacements. On both types of farms, some additional forage was purchased.

Labor Available for Chore Work, and Requirements for Cows and Young Stock

The labor used on the dairy herds of farmers who raised all their replacements and of those who bought replacements did not differ significantly. Standard labor requirements for cows and young stock were summarized from reports of previous studies in New Hampshire.

Available Barn Space and Utilization by Cows and Heifers

Most of the sample dairy farms visited had conventional stanchion-type barns. Only about 10 percent of the farms fully utilized this space

for carrying cows. Many farms had cow stanchions that were idle or filled with young stock. All farms had some barn facilities that were designed for use only by young stock.

Flexibility and Limitations in the Use of Resources for Either Cows or Young Stock

The adjustments possible in substituting cows for replacements depend largely on the flexibility of the resources on the farm.

In general, good forage can be used to carry either cows or young stock. Pasture is not so flexible in its utilization, but of the dairymen surveyed, 70 percent indicated that they had some pastures that they could use only for grazing young stock and in some instances dry cows.

Both groups of farms had some barn facilities designed for use only by young stock. Farmers who bought some replacements could house on the average only 14 head of young stock in specialized facilities. Farmers who raised all their own replacements had specialized facilities for housing 19 head of young stock. Both groups of farms had additional space available for cows; it was currently idle or was used to house replacements. Although both groups of farms carried about 25 cows, space was available for carrying 35 cows on the average.

An average of 18 animal units was cared for per farm worker on both types of farms. Eighty-five percent of the farmers thought they could expand their herds with their present labor supply. With sufficient forage and barn space, they believed they could carry an average of 17 additional cows per farm with their present labor force.

Prices Paid and Received

Two levels and relationships of prices paid and prices received were selected for use in budgetary analyses. They represent two different price patterns that dairymen have experienced in the recent past. The two sets of prices differed enough to represent both the situation nearby and that farther from the Boston market.

Economic Analysis

The purpose of the economic analysis was to combine the foregoing physical production relationships and the price relationships into an analysis of the costs and returns that would be experienced by a typical dairy farmer with alternative combinations of cows and young stock. The dairy farm used in this economic analysis was modeled after the sample farms visited.

Short-Run Adjustments

Four alternative short-run adjustments were tested. Alternative 1 would involve no basic changes in the farm organization other than a shift in source of replacements. The change would be a shift from 25 cows and raised replacements to 29 cows and purchased replacements. It would require no additional capital investment. About the same number of hours per year were required to operate the crop and livestock enterprises. Some additions to net farm income would be realized. Alternatives 2, 3, and 4 involved varying amounts of additional forage, labor, and capital investment. Larger additions to net farm income would be obtained from these alternatives than from alternative 1. The additional income was greater under price situation II, which represents prices received and those paid

in 1954-55 than under price situation I, which represents prices in 1951-52.

In general, it pays to carry as many cows as possible regardless of the effect on numbers of replacements raised. Individual farm situations determined whether or not the residual inflexible resources should be used to raise replacements. In most instances, they should be. The problem of inflexibility in resources is important in the short run. The physical production relationships provided in this bulletin may be used by individual farmers to determine whether it will be profitable to use these resources.

Long-Run Adjustments on Dairy Farms

Over longer periods of time, old barns are remodeled, new barns are built, and size of farms, labor force, and land use are changed. In the long run, most of the resources on New England farms are flexible as to use with the price levels and price relationships that have prevailed for milk, cull cows, and replacements. A series of farm budgets were developed for a typical farm on the assumption of resource flexibility. Also, to provide a more general application of the physical production relationships developed in the study, farms ranging in size from milking herds of 11 to 52 cows were grouped into six equal size classifications. An analysis of costs and returns was made for each group. The separate effects on net farm income of changes in the price of milk, the price of cull cows and veal calves, and the price of replacements were computed for the two general price situations. Break-even prices of milk, cull cows, and replacements — the prices at which it would be a matter of indifference to the farmer whether he would raise or buy his replacements — were identified. For more generalized application of the production data, the effect on net farm income of varying prices of replacements, cull cows, and milk for each of the six farm size groups was computed at three levels of milk production per cow. In general, the additional net farm income obtainable by shifting from raising to buying replacements was largest with the combinations of low prices for replacements, high prices for beef, high prices for milk, and a high level of milk production per cow.

In the long run, New England dairymen would find it economically advantageous to shift from raising to buying replacements within the framework of current prices and technology. A major change in the relationship of prices for replacements and milk would probably result, however, if a large number of dairymen stopped raising replacements. It may be that the price of replacements in New England has been low historically because many farmers believed that raised replacements were cheaper and better.

Adjustments in Obtaining Dairy Herd Replacements

By G. E. Frick and W. F. Henry[1]

Introduction

Agriculture in New England is becoming more and more specialized. New England dairy farms had other profitable enterprises, such as potatoes, field crops, poultry, or other livestock. But modern machinery, improved production practices, and increased competition from newer agricultural areas have gradually reduced the economic advantages of supplementary enterprises on the dairy farm.

The pressure toward specialization raises questions about the future of dairy farming in New England. In particular, it raises the question as to the direction future specialization should take to permit even more economic utilization of resources on dairy farms.

An adjustment opportunity in which there is widespread interest is whether a New England dairyman should raise or buy replacements for his dairy herd. Does the raising of dairy herd replacements represent the best use of individual farm resources and the development of the New England dairy economy? In some areas in the United States, milk is produced under highly specialized systems that do not include production of feed and dairy replacements. New England dairymen are aware of this, and they want help in deciding the extent to which they should specialize.

Recent Situation in Dairy Replacements

For many years, dairy farmers in New England have devoted a large part of their productive resources to the raising of dairy replacements. Each year from 1945 through 1954, an average of 166,000 dairy animals were raised to replacement age. To raise 166,000 replacements per year required about 463,000 tons of hay or hay equivalent; the equivalent of 127,000 acres of improved legume rotation pasture; 7 million hours of man labor; and 216,000 stanchions, or 11.6 million square feet of loose-type stabling.[2] If all these resources could have been used for cows instead of for young stock, it would have been possible to keep about 80,000 more cows.

A certain amount of specialization in milk production apparently is profitable on New England dairy farms, because in the last 10 years not enough replacements have been produced in New England to fill the needs.

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[2]G. E. Frick and W. F. Henry, *How Many Replacements Should a Dairyman Raise?* Cooperative Extension Service, University of New Hampshire, and the former Bureau of Agricultural Economics, U.S.D.A., cooperating.

In southern New England, the inshipments of dairy cattle for replacements have been consistently large. In northern New England, the movement has fluctuated from small inshipments in some years to small outshipments in other years. In New England as a whole, net inshipments of dairy replacements amounted to 18 percent of the replacements (table 1). During the same period, inshipments amounted to 41 percent of the total replacements in southern New England but to only 2 percent in northern New England. In 1954, northern New England actually produced a surplus of replacements, but the number produced was not nearly enough to supply the deficit in southern New England.

If all the inshipments for replacements in New England in 1954 had been produced in the area, it would have required about 42,000 tons of hay or hay equivalent, and an equivalent of 12,000 acres of improved legume rotation pasture, 675,000 hours of man labor, and 20,000 stanchions, or 1 million square feet of loose-type stabling. If these resources had been diverted from production of milk in order to raise more replacements, it would have been necessary to dispose of about 12,000 cows.

Table 1. Net Inshipments and Total Replacements of Dairy Cattle, New England, 1945-54 and 1954[1]

Area	Net Inshipments		Total Replacements Made		Percentage Net Inshipments Were of Total Replacements Made	
	Average 1945-54	1954	Average 1945-54	1954	Average 1945-54	1954
	Number	Number	Number	Number	Percent	Percent
Southern New England	34,750	22,550	85,000	82,550	41	27
Northern New England	2,800	—7,550	119,100	132,450	2	—6
New England	37,550	15,000	204,100	215,000	18	7

[1]Interstate Movement of Dairy Cattle, 11 Northeastern States, Agricultural Marketing Service, U. S. Department of Agriculture, 1946-1955.

In New Hampshire in the same period, the number of replacements per year varied from around 15,000 to 22,000 and averaged about 19,000. Although the number of replacements raised in relation to the number made varied somewhat from year to year, there were no large surpluses or deficits of home-raised replacements. Home-raised replacements did not vary from local needs by more than a 6 percent deficit or a 6 percent surplus (Table 2).

The data on interstate shipment of cattle do not give a full indication, however, of the number of purchased animals on farms. Many animals are bought within the boundaries of the States. Therefore, they do not enter into the category of interstate commerce. For instance, during 1953, New Hampshire had a net outshipment of 370 dairy cattle. Yet a survey of 229 New Hampshire dairy farms showed that 64 percent of the herds had some purchased animals. On about 80 percent of the farms surveyed, between 50 and 100 percent of the animals in the herd were raised on the farm (Figure 1). But of the total of 6,480 cows on these farms, 1,556, or 24 percent, were bought.

Table 2. Net Inshipments and Total Replacements of Dairy Cattle in New Hampshire, 1945-54[1]

Year	Net Inshipments	Total Replacements Made	Percentage Net Inshipments were of Total Replacements Made
	Number	Number	Percent
1945	1,137	22,150	5
1946	1,075	19,100	6
1947	—151	20,850	—1
1948	722	19,700	4
1949	—334	16,650	—2
1950	—569	20,450	—3
1951	—866	16,150	—5
1952	—853	15,150	—6
1953	—370	17,650	—2
1954	—480	21,500	—2

[1]Interstate Movement of Dairy Cattle, 11 Northeastern States, Agricultural Marketing Service, U. S. Department of Agriculture, 1946-1955.

The culling rate for both New England and New Hampshire varied considerably from 1945 through 1954 (Table 3). The rate reflects both the technological status of dairy cow management and the relationships between the prices for resources used in dairying and the prices for dairy products. The variation in the culling rate indicates that, although many animals must be culled for disease or other reasons, there is some leeway when it comes to culling cows because of low production. The question of whether to cull a cow based solely on her production depends on the quality of animals available for replacement and the price relationships between milk, cull cows, and replacement stock.

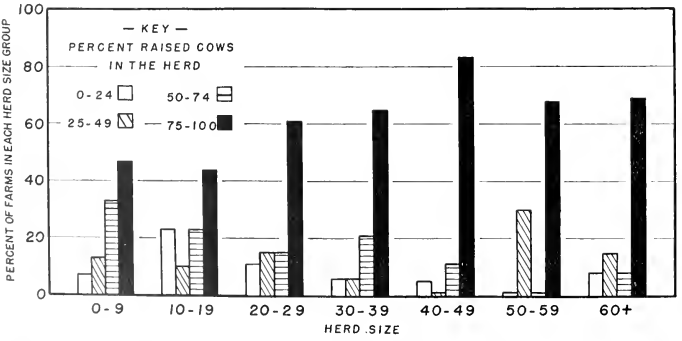

Figure 1. Percentage of raised cows in the herds on 229 New Hampshire dairy farms, classified by herd size, 1953.

Table 3. Annual Rates of Culling of Dairy Cows in New England and New Hampshire, 1945-54[1]

Year	Rate of Culling			
	New Hampshire	Southern New England	Northern New England	New England
	Percent	Percent	Percent	Percent
1945	24	31	23	27
1946	21	31	21	26
1947	23	29	24	27
1948	22	33	23	28
1949	19	25	18	22
1950	24	28	23	25
1951	19	26	18	22
1952	17	19	14	17
1953	20	22	18	20
1954	23	25	20	22

[1]Interstate Movement of Dairy Cattle, 11 Northeastern States, Agricultural Marketing Service, U. S. Department of Agriculture, 1916-1955.

Considerations Involved in Appraising the Replacement Problem

STATED BRIEFLY, in considering his replacement problem, a dairyman must decide what proportion of his farm resources to devote to the production of dairy replacements and what proportion to the production of milk. Hay can usually be fed to either cows or young stock. Most pasture is equally suited to grazing by cows or young stock. Labor can be utilized in taking care of either cows or young stock. In other words, the dairyman must decide how he can best use his feed, building space, labor, and other production facilities in view of the costs of these production facilities and the prices he receives for his products.

Location of the individual farm affects culling and replacement practices to some extent. In general, farms that are near markets where prices for milk are high, as in southern New England, tend to raise few replacements and concentrate resources on production of milk. Farms farther from markets where prices of milk are less favorable tend to have a higher proportion of young stock to milking cows. But, aside from some differences that result from location with respect to market, the problem of deciding how to use production resources must be solved within the framework of the individual farm situation.

An economic evaluation of the use of production resources on a dairy farm with respect to the number of herd replacements that should be raised or bought must take into account several common beliefs. It is sometimes argued that a program of raising all replacements for the dairy herd is better than buying some or all replacements because it is difficult to build a high-producing herd with purchased replacements. The risk of getting brucellosis, mastitis, or other diseases in the herd is believed to be much greater with purchased cows. It is often said that a farmer's investment in labor and feed in raising a replacement is less than the price he would pay for the same heifer. It is also felt that with good manage-

ment, home-grown replacements can be grown to the correct size for breeding at an earlier age. Proponents of raising replacements on the farm also advance the argument that the productive life span is longer for raised replacements, and that raised cows produce more milk than purchased cows.

Most farms present a dynamic adjustment picture. Adjustments in both size of operation and production practices are continually taking place. Thus in observing actual practices on a farm, it is difficult to decide what part of the change in net farm income is due to the adoption of a certain practice and what part is due to a change in size of business that often accompanies changes in practices or management. Farm budgets, however, permit testing the effect on income of changes in farm organization or practices with the same quantity of farm resources. In other words, it is possible to estimate the net effect of a proposed change in organization independently of a change in size of business.

In this appraisal of the net effect of various types of replacement practices, the several farms considered differ as to proportions of resources and with respect to location in the milkshed, but the individual farm resources were assumed to remain unchanged. The system of obtaining replacements was varied from raising all replacements, to raising some and buying some, and to buying all of them. Thus the true net effect of the changes in management on income from each of the farms was obtained.

Sources of Information for Appraisal of Replacement Problem

A FARM survey and records from the New Hampshire Dairy Herd Improvement Associations were the major sources of information for the study. The survey included 62 dairy farms that differed with respect to location in the Boston milkshed and size of herd. The types of information that were obtained consisted of the farmer's attitude toward purchased replacements, numbers of livestock, disease control and prevention practices, supply of forage, barn facilities, and labor force. The New Hampshire Dairy Herd Improvement Association records provided information on herd life, age at disposal, reasons for disposal, production of milk, and age composition of cows in a large number of herds. Data from each source were used throughout the study wherever applicable.

The major kinds of data assembled and analyzed were as follows:

(1) Feeding rates for cows and young stock.
(2) Milk production rates for raised and purchased cows.
(3) Mortality and culling rates for young stock.
(4) Incidence of disease, years in herd, age at disposal, and life expectancy for raised and purchased cows.
(5) Yields for hay, silage, and pasture.
(6) Chore work for cows and young stock.
(7) Available barn space and utilization by cows and young stock.
(8) Flexibility and limitations in use of resources for either cows or young stock.
(9) Prices for products sold and purchased.

Feeding Rates for Young Stock and Cows

Consumption of forage and concentrates per head depends on the animal's age, size, rate of growth, and production, and upon economic conditions through their effect on management. The type of management provided by a dairyman is one of the most variable factors.

The feed inputs for producing home-raised replacements that were used in the budgetary analysis in this study are given in Table 4. They were typical quantities of forage and concentrates fed to calves and young cattle on a sample of New Hampshire dairy farms.

Table 4. Typical Feed Inputs per Head per Year for Young Stock From Birth to Freshening, 62 New Hampshire Dairy Farms

Feed	Unit	Quantity
Milk	Pound	75
Milk substitutes	Pound	50
Grain	Pound	1,200
Hay		
Only forage fed	Ton	2.8
Fed with silage	Ton	1.9
Silage fed with hay (hay equivalent)	Ton	.9
Pasture (hay equivalent)	Ton	2.0

The age-growth relationship with these inputs for 180 head of Holstein young stock are shown in Figure 2. A fitted curve of the relationship is compared with normal weights for animals at various ages as reported by Matthews and Fohrman.[3] In Figure 2 the growth rates in the early ages are close to the normal growth rate, but as the young stock advance into the yearling age group, the rate of growth slackens considerably. This may be due partly to the fact that young dairy cattle are commonly pastured on relatively poor permanent pasture. Poor feeding and retarded growth in heifers, however, probably does not affect adversely their lifetime performance. Experiments of the effects of nutrition during the early life of dairy heifers, for which only preliminary results are available, indicate that the heifers that are poorly fed before the first parturition may have as good, or better, lifetime productive and reproductive performance as the heifers that are fed liberal rations according to Morrison standards.[4]

The feeding rates for cows that were used in the budgetary analysis of this study are given in Tables 5 and 6. They are based on physical relationships observed under controlled feeding experiments, but records obtained in the farm survey indicate that they are representative of the level of feeding on New Hampshire dairy farms. The 32 Holstein herds included in the survey sample consumed an average of 5.3 tons of forage as hay equivalent per cow annually. Variations in the quantity per cow in different herds were due to availability of forage and the level of grain feeding.

[3]Matthews, C. A. and Fohrman, M. H., *Beltsville Growth Standards for Holstein Cattle*, U.S.D.A. Tech. Bul. 1099. 1954.

[4]Reid, J. T., "Effects of Several Levels of Nutrition Upon Growth, Reproduction, and Lactation in Cattle," 1953 Cornell Nutrition Conference Proceedings.

Table 5. Estimated Annual Consumption of Feed Per Head, Large Cows

Grain Fed (Pounds)	Forage Consumed[1]	
	Fair Forage — Hay Equivalent	Good Forage — Hay Equivalent
	Tons	Tons
0	5.9	6.4
500	5.6	6.1
1,000	5.4	5.9
1,500	5.2	5.6
2,000	4.9	5.4
2,500	4.7	5.2
3,000	4.4	4.9
3,500	4.2	4.7
4,000	4.0	4.4
4,500	3.7	4.2

[1] Adapted from Jensen, et al. *Input-Output Relationships in Milk Production*, U. S. Dept. Agr. Tech. Bul. 815 (1942) by R. G. Wheeler, Harvard University.

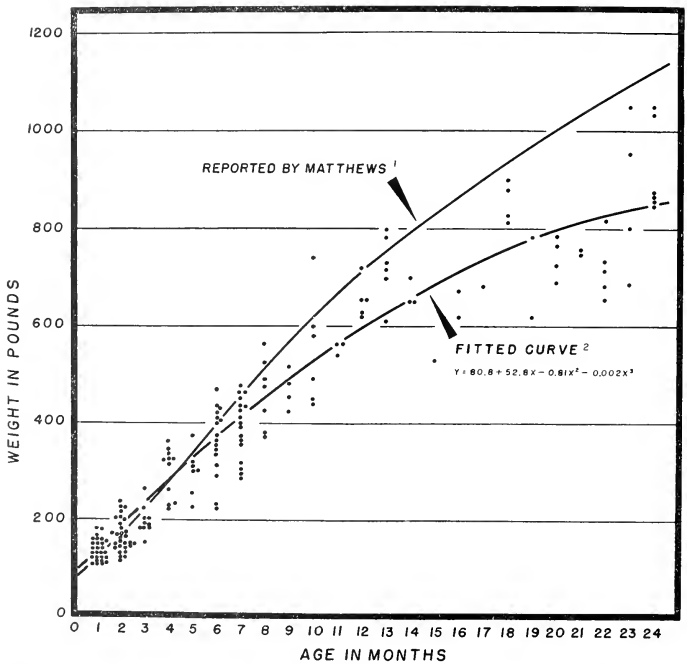

Figure 2. The relationship between age and weight for 180 Holstein cattle compared with normal weights reported by Matthews and a typical growth curve.

[1] C. A. Matthews, *op. cit.*

[2] Applies only to the first two years of growth.

Table 6. Suggested Levels of Grain Feeding for Complete Lactation In Relation to Grain-Milk Price Ratio[1]

Grain-Milk Price Ratio[2]	Pounds of Milk Produced Requiring One Pound of Grain	
	Fair Forage — Hay Equivalent	Good Forage — Hay Equivalent
	Pounds	Pounds
1.60	13.5	—
1.45	10.5	—
1.30	8.0	18.0
1.15	6.5	14.0
1.00	4.5	10.0
.85	3.5	7.0
.75	2.5	5.0

[1]Estimates based on Jensen, et al., *op. cit.*, and on Kitchen, et al., *Cows — Hay Burners or Grain Burners* (mimeo.) New Jersey Agr. Expt. Sta.

[2]Derived by dividing the price of 100 pounds of grain by the price at the farm of 100 pounds of milk.

Milk Production Rates for Raised and Purchased Cows

Records of milk production for raised and purchased cows were taken from New Hampshire Dairy Herd Improvement Association herd books for 25 farms. A total of 358 records of 305-day lactations were used. For each record for a raised cow, a similar record was obtained for a purchased cow of the same breed in the same herd that freshened on the same date. The paired production records for raised and purchased cows were converted to a 4-percent fat-corrected basis.

The levels of milk output of pairs of raised and purchased cows in the same herd and in the entire sample were compared. Although production of raised and purchased cows varied considerably in individual herds and among herds, there appeared to be no consistent pattern of superiority of either raised or purchased animals (Figure 3). The average production of 4-percent fat-corrected milk for all purchased cows and all raised cows was about the same. Purchased cows produced on the average 10,608 pounds of 4-percent fat-corrected milk while raised cows produced on the average 10,216 pounds. The difference of 392 pounds of milk in favor of the purchased cows was not significant when tested statistically: it could have occurred by chance.[5] The average level of production of 4-percent fat-corrected milk for raised cows exceeded that of purchased cows in 10 of the 25 herds in the sample.

As purchased cows averaged 2.4 years older than raised cows, the production records were further corrected to a mature-cow equivalent basis to obtain better comparison of the quality of cows, as reflected in production of milk. Differences in production between raised and purchased cows still existed (Figure 4), but the distribution of the production of purchased cows was similar to that of raised cows. The average production (mature-cow equivalent) for the group of raised cows was 11,272 pounds of milk, and production of the purchased-cow group averaged 11,189 pounds of milk. The difference in production of 83 pounds of milk, however, when

[5]A Student's t test was used and the difference in average production was not significant at the 5-percent level.

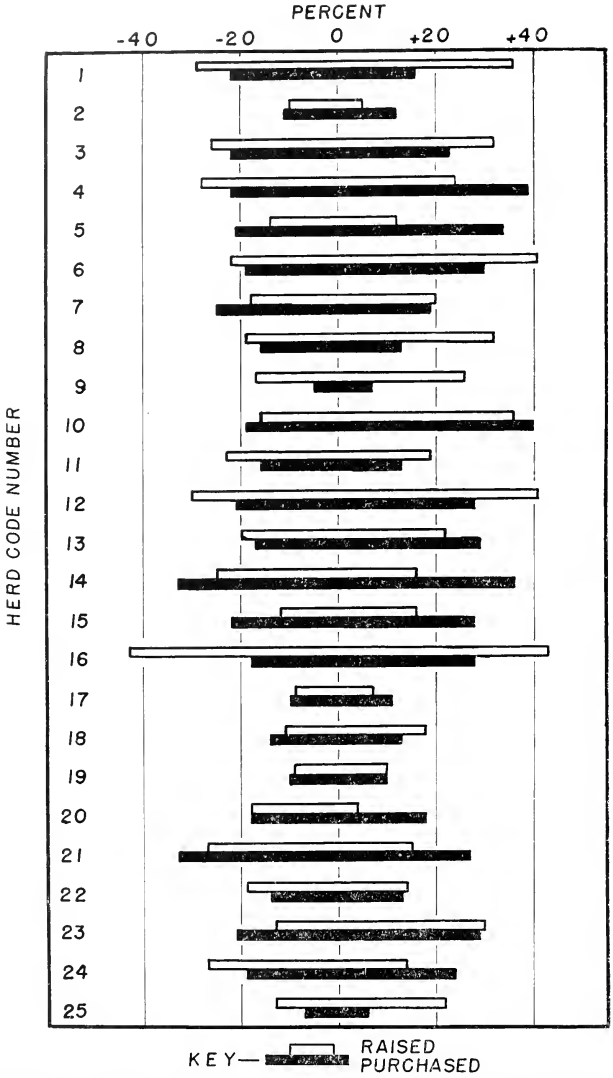

Figure 3. Range in percentage variation of the annual puroduction of individual cows from the average production of the herds, raised and purchased cows, by herds.

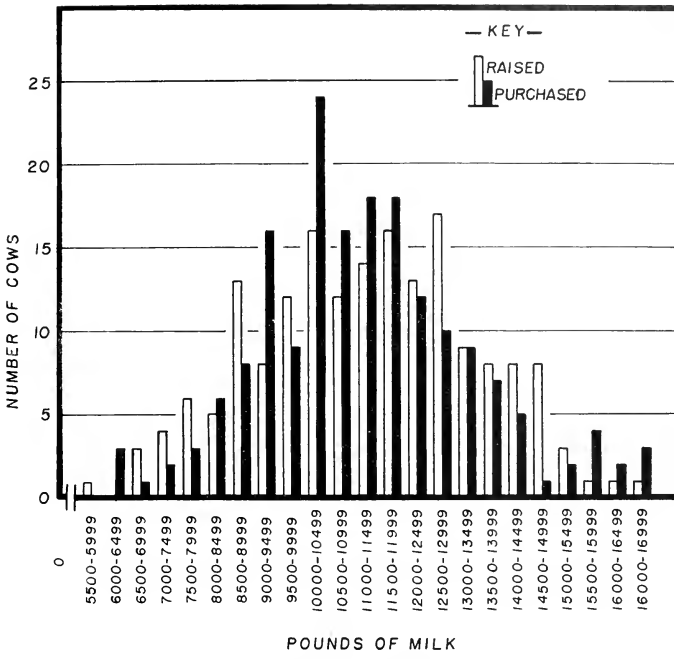

Figure 4. Distribution of a sample of 179 pairs of raised and purchased cows according to production of 4 percent fat-corrected milk, the level of milk production corrected for age of the animals.

tested statistically, was not significant.[6] Therefore, it was concluded that for this sample of cows, raised and purchased cows that were comparable with respect to age, breed, date of freshening, management, and fat content, produced about the same quantity of milk. In this way, they were alike in quality.

A comparison of the levels of milk production for the purchased and raised cows in the sample of farms surveyed substantiates the conclusion that these cows are similar in their ability to produce milk. The 24 herds that contained only raised cows averaged 8,343 pounds of 4-percent fat-corrected milk. Herds that contained only purchased cows averaged 8,114 pounds. The difference of 229 pounds in favor of herds made up of raised animals was small. It was less when only herds of the same breed were compared. Twelve Holstein herds made up of raised cows averaged 8,321 pounds of 4-percent fat-corrected milk. Twenty Holstein herds that contained some purchased cows averaged 8,486 pounds of 4-percent fat-

[6] A Student's t test was used and difference in average production was not significant at the 5-percent level.

corrected milk. When only cows of the same breed were compared, the production of herds with purchased cows exceeded that of herds with raised cows by 165 pounds of milk. Thus small differences in average herd production probably cannot be attributed to whether the cows were raised or purchased. Apparently raised and purchased cows are equal in milk-producing ability.

Calves Born per Cow, Mortality, Sex Ratios and Sterility Rates

In the economic analysis of dairy herd replacements that follows, it is assumed that the calving interval ranges between 390 and 410 days, which results in about 0.90 calvings per cow each year. This is based on Gilmore's service-conception rates and an estimated 4-percent sterility in the cows of breeding age. A calving interval of 400 days is realistic for New Hampshire conditions if there are no special management decisions that lengthen the calving period.

Most dairymen attempt to breed a cow 2½ to 3½ months after calving, which results in about 1 calving per year and, as shown by Peterson, the highest milk production for the lactation.[7] More specifically, a gestation period of 280 days and conception at 2½ months after calving results in a calving interval of 355 days. But all cows do not conceive on the first service. Boynton found from the records of the New Hampshire-Vermont Breeding Association for the years 1950 through 1953 that of 152,109 cows that were bred, only 66.8 percent conceived on the first service.[8] Gilmore showed from the records of 16,954 fertile cows that about 65 percent conceived on the first service. 20 percent on the second service, 8 percent on the third, 4 percent on the fourth, and 3 percent on the fifth or more service.[9] If all farmers bred their cows about 2½ months after calving, and they obtained the conception rate shown by Gilmore, the calving interval would be about 365 days. However, farmers may not detect the first heat period at around 2 months and thereby may delay the opportunity to breed for another 18 to 21 days. They may also lengthen the dry period for some reason — in most instances to change the freshening dates to coincide better with the season when milk prices are highest.

Results of other studies of calving interval appear to bear out the existence of these management elements. A report on 87,053 calvings in 108,522 cow years showed 0.80 calvings per cow year, or a calving interval of 456 days.[10] Another report showed that the calvings per cow year were 0.82 and 0.86, which are equivalent to calving intervals of 446 and 424 days.[11]

Not all female calves born live to enter the milking herd. Table 7 shows data on the mortality and sterility rates for dairy heifers which were sum-

[7] W. E. Peterson, *Dairy Science*, J. B. Lippincott Company, Second Edition, 1950.

[8] C. H. Boynton, *Reproduction in Dairy Cattle*, University of New Hampshre Ext. Bul. 115, 1954. This level of 66.8 percent conception is probably 5 percent too high because of the culling of some animals bred once and not settled and then sold.

[9] L. O. Gilmore, *Dairy Cattle Breeding*, J. B. Lippincott Company, 1952.

[10] L. H. Beard, "Relation of Bovine Age to Season of Calving," Unpublished Thesis, Iowa State College, Ames, Iowa, 1933.

[11] J. Ingals and C. Y. Cannon, "The Mortality of Calves in the Iowa State College Dairy Herd," Journal Paper No. J 387, Iowa Agr. Expt. Sta., 1936. W. W. Yapp and A. F. Kuhlman, "Breeding Results in a Herd of Cattle Infected with Contagious Abortion," American Soc. Anim. Prod. Proc. 1932: 277-281, 1933.

marized chiefly from records for well-managed college herds. The incidence of mortality and sterility probably was less than in commercial herds. Results of the various observations differ, but even so the percentage of calves that were born dead or died at birth represented a considerable part of the total number of animals born. Three herd records, each of which covered a group of heifers from birth to calving, showed that 66 to 83 percent of the females born lived to calve.

Many of the animals that were born dead or died at birth were twins or a twin. About 3 percent of all births are twin births.[12] Twins are smaller and less vigorous than singleton calves and according to Peterson they have a death rate three times that of single-birth calves.[13] In a sample of 34 New Hampshire twin births, 17 of the 68 animals, or 25 perecent, were born dead or died at birth. In the New Hampshire sample reported in Table 7, twins accounted for 3 percentage points and singleton calves for 3.5 percentage points of the 6.5 percent of the calves that were born dead or died at birth. The death rate for twin calves was about seven times that for singleton calves in this New Hampshire Herd.

Another problem associated with twin calves is that the female in a bisexed birth is sterile 9 in 10 times.[14] This means that of the twins that live, many of the females must be culled for sterility. Theoretically, fraternal twins occur in the ratio of 1 male pair, 1 female pair, and 2 male-female pairs. In dairy cattle, the ratio of fraternal twins to identical twins is 96 to 4.[14] Thus the expected frequency of different sex combinations would be 27 percent male pairs, 48 percent male-female pairs, and 25 percent female pairs.[15] This includes correction for both the incidence of fraternal and identical twins as reported by Bonnier and the sex ratio for multiple births as reported by Gilmore.[16] From the standpoint of producing replacements, twinning is undesirable. One hundred twin calvings normally produce 43 potentially fertile heifers while 100 singleton calvings produce 46 potentially fertile heifers.

The sex ratio of single-birth calves also affects the normal increase in numbers of dairy cows. Records on 213,698 calves showed 51.2 percent males and 48.8 percent females.[17] For twin births, the sex ratio decreases to 49.1 percent males and 50.9 percent females. Even so, the number of male calves born exceeds the number of female calves born.

The compound effect on the natural increase in the cow population of calves born per cow, calf mortality, twinning, sex ratios, and sterility is shown in Figure 5. For each 1,000 cows, there would be 900 calvings each year, 873 singleton calves and 54 twin calves, or a total of 927. Of the 873 singleton calves, 5 percent would be born dead or die at birth — a loss of 44 calves. The ratio for singleton calves would be such that of the 829 calves alive, 404 would be potentially fertile females. The rest of the singleton calves would be sold for veal. Of the 54 twin calves, 20 per cent would be lost and 70 percent of the 43 calves alive would be sterile.

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[12]See Appendix Table 8 for a summary of the proportion of twin births among all births of dairy cattle.

[13]W. E. Peterson, *Dairy Science, op. cit.*

[14]Gert Bonnier, "Studies on Monozygous Cattle Twins. II. Frequency of Monozygous Cattle Twins." Acta. Agr. Suec. I, 147-151, 1946.

[15] $(P + Q)^2$ where P equals percent males and Q equals percent females.

[16]Gert Bonnier, *op. cit.*, and, L. O. Gilmore, *Dairy Cattle Breeding, op. cit.*

[17]See Appendix Table 7 for a summary of the sex ratio of dairy cattle.

Table 7. Mortality and Sterility rates of Heifer Calves in Various Herds

Herd	Born	Percentage Born Dead or Died at Birth	Alive After Birth for Raising	Percentage Mortality of Those Alive After Birth		Alive at Breeding Age	Percentage Sterile of Those Alive at Breeding Age	Alive and Able to Enter the Milking Herd[1]	Percentage of Females Born That Live and Are Fertile
				Birth to 6 Months	6 Months to 18 Months				
	No.	Percent	No.	Percent	Percent	No.	Percent	No.	Percent
Iowa[2]	600	8.3	550	—	15.6[3]	464	10.0	417	69.5
Minnesota[4]	—	—	—	—	—	311	7.4	288	—
Maine[5]	—	8.0	—	—	—	—	—	—	—
Florida[6]	408	4.9	388	12.9	7.2	310	12.6	271	66.4
Missouri[7]	—	13.7	—	—	—	—	—	—	—
Connecticut[8]	—	—	1,077	7.2	—	—	—	—	—
Illinois[9]	809	5.9	761	—	24.0[10]	—	—	—	—
Minnesota[11]	592	8.4	442	28.7	—	—	—	—	—
Minnesota[11]	1,007	6.1	946	11.7	—	—	—	—	—
Michigan[12]	1,467	6.6	1,370	7.6[13]	—	—	—	—	—
Nebraska[14]	1,178	9.2	1,069	—	13.6[15]	—	—	—	—
New Hampshire[16]	460	6.5	430	7.6	0.3	396	3.6	382	83.0
Kansas[17]	28,897	5.2	27,912	—	—	—	—	—	—

[1] Data do not include deaths between 18 months and freshening.

[2] J. Ingals and C. Y. Cannon, "The Mortality of Calves in The Iowa State College Dairy Herd," Journ. Paper No. J 387, Iowa Agr. Expt. Sta., 1936. Proceedings of the American Society of Animal Production 29th Meeting, 1936.

[3] From birth to freshening.

[4] C. H. Eckles, *A Study of Breeding Records of Dairy Herds*, Minn. Agr. Expt. Sta. Bul. 258, 1929.

[5] G. Dow, *Costs and Returns, Producing Milk, Raising Heifers, and Keeping Herd Bulls*, Maine Agr. Expt. Sta. Bul. 361, 1932.

[6] P. T. Dix Arnold and R. B. Becker, *Dairy Calves, Their Development and Survival*, Fla. Agr. Expt. Sta. Bul. 529, 1953.

[7] A. C. Ragsdale, E. C. Elting and S. Brody, *Growth and Development*, Mo. Agr. Expt. Sta. Bul. 96, 1926.

[8] R. E. Johnson, E. L. Jungherr and W. N. Plastridge, "Calf Losses in a Self-contained Herd Over a Period of Seventeen Years," (Storrs Agr. Expt. Sta.), Jour. of Dairy Sci., Vol. 31, August, 1948.

[9] E. E. Ormiston, "Calf Losses in a Dairy Herd Consisting of Five Breeds," Jour. of Dairy Sci., Vol. 32, August, 1949.

[10] To end of first year.

[11] K. Miller and L. Gilmore, "Calf Mortality, Sex Ratio and Incidence of Twinning in Two University of Minnesota Herds," Jour. of Dairy Sci., Vol. 32, August, 1949.

[12] E. Weaver, R. E. Horwood and E. S. Smiley, *Losses of Calves in Dairy Herds*, Mich. Agr. Expt. Sta. Quar. Bul. 32, 1:42-47, August, 1949.

[13] From birth to 10 months.

[14] H. P. Davis, *Dairy Calf Births and Disposals*, Nebr. Agr. Expt. Sta. Bul. 411, 1952.

[15] To freshening.

[16] Compiled from records of the University of New Hampshire dairy herd for the period 1942 through 1952.

[17] Dairy News Letter, Kansas Agricultural Extension Service (Monthly Mimeo.) 1953 and 1954.

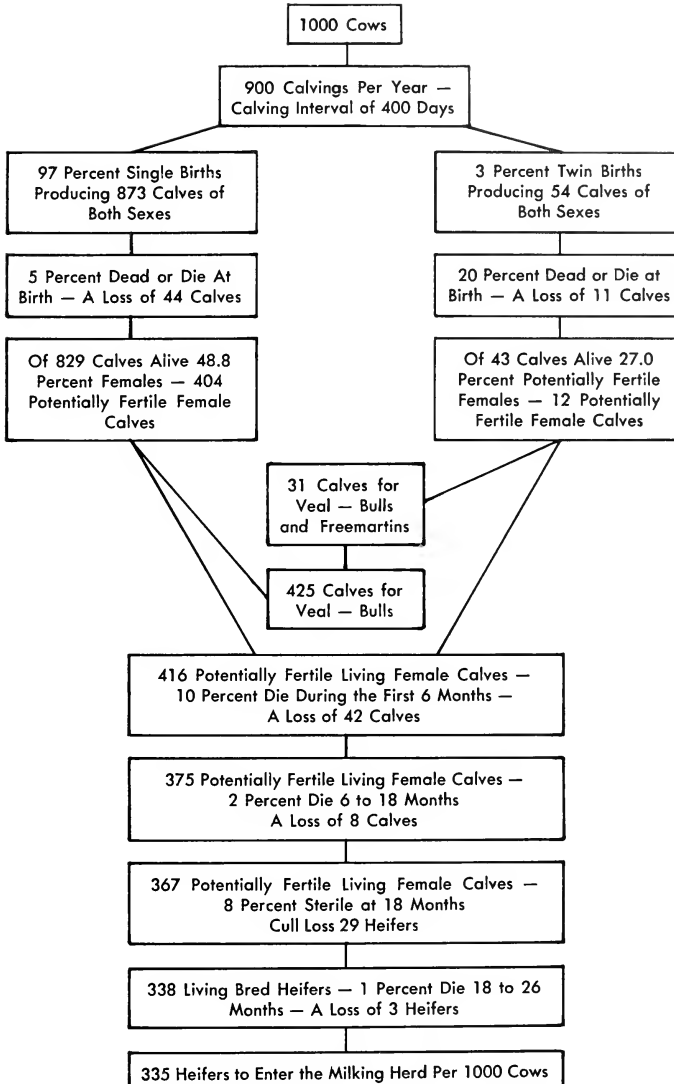

Figure 5. Replacement rate with good commercial management.

This would leave only 13 potentially fertile females. Thus, of the singleton and twin births, 455 would be sold as males or infertile females. Of the 417 potentially fertile female calves alive after birth, 10 percent would die before they were 6 months old. This leaves 375 females, of which 2 percent would die between 6 and 18 months of age. Of the 367 females that reach 18 months, 8 percent are sterile and are culled. This leaves 338 bred heifers, of which 1 percent would die before freshening. This would leave a total of 335 to enter the herd. Thus with 1,000 cows and with a normal sex ratio of calves, 335 replacements can be raised under good management.

The replacement rate shown in Figure 5 is an estimate of the number of replacements that could be raised per 1,000 cows. Under farm conditions, however, both heifer calves and heifers are culled for economic reasons. Table 8 shows the estimated number of heifer calves born and the number raised in New Hampshire from 1945 through 1954. It also shows the numbers of heifers 1 to 2 years old and heifers 2 years and over per 1,000 cows. Taking mortality and sterility into account, an estimate was made of the number of heifers calving per 1,000 cows and heifers 2 years old and over. This is an estimate of the actual replacement rate, which covers culling for economic reasons, such as adjustments to other resources on the farm and current and prospective changes in prices.

A comparison of the actual replacement rate (Table 8) with the potential replacement rate (Figure 5), gives an approximation of the additional number of heifers that could have been raised for replacements. The number varied annually from 47 to 122 per 1,000 cows and heifers 2 years old and over for 1945 through 1954. Apparently farmers have culled around 5 to 12 percent of the annual heifer crop for herd improvement or other economic reasons. This indicates roughly the possibilities for expansion or improvement of herds through breeding and closer culling of cows. That is, only 5 to 12 percent of the annual heifer crop that was culled could be used to increase the size of the herd or for selection of female calves to increase milk production per cow, as most of the female calves born must be used to maintain the cow population.

The net reproduction rate or ratio of animals in two consecutive generations is a more accurate measure of the amount of selection available in heifer calves. With the assumed average levels of management, fertility (Figure 5), mortality and culling (Tables 9-10), 1,000 2-year-old females would produce 1,559 2-year-old females by the end of their productive lifetime.[18]

The increase from 1,000 to 1,559 2-year-old females in one generation is at the rate of 559 per 1,000. This may be interpreted to mean that during the average generation life of 4.69 years for New Hampshire cows, each cow could provide a replacement and 0.559 of a cow for an increase in the cow population or for selection and upbreeding through culling.

The true rate of natural increase may be derived from the net reproduction rate. This annual rate of increase is the ultimate rate of increase for New Hampshire cows in this sample with the assumed conditions of management, fertility, mortality, and culling. It measures the actual capacity for growth of the State's cow population without purchase of outside animals. For the sample of New Hampshire Dairy Herd Improvement

[18] For a discussion of reproductive rates and methods for determination, see L. I. Dublin, A. J. Lotka, M. Spiegelman, *Length of Life*, The Roland Press Co., New York, 1949.

Table 8. Estimated Livestock Numbers and Numbers of Heifers Freshening per 1,000 Cows, New Hampshire, 1945-55

Year	Cows and Heifers 2 Years Old and Over[1]	Heifer Calves Born[2]	Heifer Calves on Hand[1]: January 1 of Following Year as Heifer Calves	Heifer Calves on Hand[1]: January 1 of 2d year as Heifers 1 to 2 Years Old	Heifers Freshening[3]	Heifers Freshening per 1000 Cows and Heifers 2 Years Old and Over
	Thous.	Thous.	Thous.	Thous.	Thous.	Number
1945	76	30	18	17	16	213
1946	74	30	19	18	17	231
1947	74	30	19	18	17	231
1948	70	28	19	17	16	231
1949	69	28	19	18	17	248
1950	70	28	20	19	18	257
1951	66	28	20	20	19	288
1952	67	28	21	20	19	283
1953	70	29	21	20	19	272
1954	72	30	19	18	17	238

[1] "Livestock and Poultry on Farms and Ranches," January 1, Crop Reporting Board, Agricultural Marketing Service, U.S.D.A.

[2] Based on the Calf Crop Reports, Crop Reporting Board, Agricultural Marketing Service, U.S.D.A. and the assumption that 49 percent of the total calves born are heifers.

[3] Based on 4 percent loss from sterility and 1 percent loss from death as the average age of the heifers 1 to 2 years old is 18 months.

Association cows, the annual rate of increase in the cow population is 101.8 cows per 1,000 cows. Over time, a farmer with 20 cows could make 2 additional replacements a year to upbreed his herd, assuming that the replacements were superior to the cows in the herd. The point is that the increase in the rate of culling of cows for herd improvement is very small.

Incidence of Disease, Herd Life, Age at Disposal, and Life Expectancy

A total of 3,078 cow-removal records was obtained for the period 1952 through 1954 from several New Hampshire Dairy Herd Improvement Associations (Table 9). These records list each cow removed from an Association member's herd and the reason for removal. The individual removal records are also classified by years in the milking herd, age at removal, and whether the cow was raised or purchased. Of the total removals, 76 percent, or 2,347 cows, were raised. The remaining 24 percent, or 731 cows, were bought. The chief reason for disposal of raised cows was for sale for dairy purposes. This amounted to about 33 percent of all disposals of raised cows. Low production ranked second; it accounted for about 23 percent of the cows removed. Sterility and udder trouble caused about 14 and 12 percent, respectively, of the cow removals. These four reasons accounted for 87 percent of the removals of raised cows. They also represented the four most important reasons for removal of purchased cows. For purchased cows, however, low production accounted for 27 percent of the removals and ranked first in importance. Sales for dairy purposes accounted for 24 percent of the removals. Sterility and udder trouble ranked the same as for raised cows and caused 17 and 15 percent, respectively, of the removals. These four major reasons accounted for 83 percent of the disposal of purchased animals.[19]

[19] The removal records for New Hampshire are similar to those reported for other states. Appendix Table 1 shows a comparison of the several reasons for removal for New Hampshire and several other states, Appendix Table 6 shows the effect of age on percentage of cows removed for New Hampshire, Kansas, and Indiana.

Cows sold for dairy purposes bring a higher price per cow than cows sold for other reasons as sterile cows and cows with udder trouble, for example, usually are sold for beef. In Table 9, the reasons for removal are also ranked for both raised and purchased cows, with cows sold for dairy purposes excluded. On this basis, all other reasons for removal accounted for similar proportions of removals, except removal of cows for low production. Low production accounted for 42 percent of the removal of raised cows, while it was the reason for only 35 percent of the removals of purchased cows. A higher proportion of purchased cows, however, were removed for miscellaneous reasons.

An analysis of the differences in relative importance of the various reasons for removal of raised and purchased cows indicates that age and selection were responsible for much of the variation.[20] Purchased cows were considerably older than raised cows when removed from the herds. Old cows are more likely to be sterile. More old cows were removed because of general physical breakdown, a reason associated with old age (and included under the heading of "Other" reasons in Table 9). Purchased cows also were selected on the basis of their ability to produce milk when they were orginally offered for sale. The farm survey of 38 dairy farms with some purchased cows indicated that of the 528 purchased animals on these farms, 447 were bought as mature cows. Thus, 85 percent of the purchased cows were selected with some tangible evidence of their milk-producing ability. Hence, it might be expected that the proportion of purchased cows removed for low production would be lower than with raised cows.

The fact that a higher percentage of purchased cows were removed because of disease — udder trouble, brucellosis, and sterility — does not indicate that purchased cows were not as healthy as raised cows of the same age. This is important because whether purchased cows introduce disease into a herd and cause a higher rate of culling is the most controversial question associated with buying replacements.

To help answer this question, Dairy Herd Improvement Association records of cow removals for a year from 62 herds with no purchased cows and from 58 herds with both raised and purchased cows were tabulated. Only the records for animals removed for reasons other than sale for dairy purposes were used. Herds containing all raised cows averaged 34.9 cows. The total removals from raised herds for reasons other than dairy purposes was 487 cows, or 7.9 cows per herd. Of the total, 200 cows, or 41 percent, were removed because of udder trouble, brucellosis, and sterility. Thus, removal for disease from herds with all raised animals was at the annual rate of 92 cows per 1,000. The raised-and-purchased herds averaged 34.2 cows. Total removals for reasons other than dairy purposes was 524 cows, or 9.0 cows per herd. Of the total, 194, or 37 percent, were removed because of udder trouble, brucellosis, and sterility. Thus, removal for disease from herds with both raised and purchased animals was at the annual rate of 93 cows per 1,000. For this sample of cows, it was concluded that the incidence of disease, as indicated by rate of removal, was no greater for herds with some purchased cows than for herds with raised cows only.

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[20] Appendix Tables 2 and 3 show the number and proportion of raised and purchased cows removed by age and by reason for removal. Appendix Tables 4 and 5 show the number and proportion of raised and purchased cows removed by length of herd life and reason for removal.

Table 9. Average Age at Disposal and Average Years in the Milking Herd for Raised and Purchased Cows Removed from New Hampshire Dairy Herd Improvement Association Herds, Grouped by Reason of Removal, 1952-54.

Reason for Removal	Raised Cows					Purchased Cows				
		Percentage of					Percentage of			
	Cows Removed from Herds	All Reasons (2,347)	Reasons Except Dairy (1,581)	Average Age at Removal	Average Years in the Herd	Cows Removed from Herds	All Reasons (731)	Reasons Except Dairy (554)	Average Age at Removal	Average Years in the Herd
	Number	Percent	Percent	Years	Years	Number	Percent	Percent	Years	Years
All reasons	2,347	100.0	—	5.52	3.34	731	100.0	—	6.74	3.17
Reasons except dairy purposes	1,581	—	100.0	5.74	3.55	554	—	100.0	7.06	3.43
Dairy purposes	766	32.6	—	5.07	2.92	177	24.2	—	5.75	2.38
Low production	663	28.3	41.9	4.88	2.72	197	26.9	35.6	6.10	2.88
Sterility	326	13.9	20.6	6.17	3.84	122	16.7	22.0	7.48	3.71
Udder trouble	292	12.4	18.5	6.41	4.14	107	14.7	19.3	7.49	3.58
Death	74	3.2	4.7	6.22	3.95	28	3.8	5.0	6.75	3.49
Accidents	47	2.0	3.0	6.30	3.92	17	2.3	3.1	7.53	3.13
Brucellosis	17	.7	1.1	6.53	4.24	10	1.4	1.8	6.70	3.40
Other	162	6.9	10.2	6.72	4.90	73	10.0	13.2	8.36	4.27

It was also found that disease control and prevention practices did not differ on farms with only raised cows and farms with both raised and purchased cows which were in the sample of 62 farms in the field survey. Table 10 shows the percentage of farmers who said they used specified practices to control disease and to prevent mastitis and brucellosis — two of the more costly diseases. The proportions of farmers with only raised cows and those with both raised and purchased cows who adopted health practices differed very little. If there was any difference, the farmers with both raised and purchased cows adopted more of the practices that are generally recommended by veterinarians.

This conclusion can be substantiated by further reference to Table 9. Average age at disposal for each reason was consistently higher for the groups of purchased cows. This reflects the fact that the purchased cows spent some time in other herds as raised cows before sale for dairy purposes. For all reasons of removal, the average age at disposal of raised cows was 5.52 years while that of purchased cows was 6.74 years. Excluding animals sold for dairy purposes, the average age at disposal for raised cows was 5.74 years and for purchased cows 7.06 years. The average age at disposal differs considerably for raised and purchased cows, but the average years in the herd for these two groups of cows was about the same — 3.34 years for raised cows removed for all reasons and 3.17 years for purchased cows. For cows removed for reasons other than sale for dairy purposes, raised cows averaged 3.55 years and purchased cows 3.43 years in the milking

Table 10. Percentage of 62 Sample New Hampshire Commercial Dairy Farmers Who Used Specified Disease Control or Prevention Practices

Disease and Control or Prevention Practice	Percentage of Farmers Who Used Specified Practices	
	Herds with Raised Cows Only	Herds With Raised and Purchased Cows
	Percent	Percent
Mastitis		
Use of strip cup	33	37
Wash udders before milking	65	85
Inflaters rinsed between cows	20	25
Inflaters boiled 1 time each week	11	25
Recommended milking machine vacuum	100	100
Recommended milking machine pulsations	100	100
Infected cows milked last	85	85
Medication given by owner	95	100
Brucellosis		
1 blood test each year	39	36
2 blood tests each year	56	58
12 blood tests each year	5	6
Calves vaccinated	87	89
Isolation of newly acquired livestock	—	6
Check with State Veterinarian before making final payment	—	3
Blood test new cattle before they enter herd	67	47
Separate freshening cows from herd	67	47
Disinfect calving areas	30	47
Destroy afterbirth	25	40
Isolate suspects or reactors	43	50
Use disinfectant pans at doorways	5	—

herd. This small difference in herd life of only 0.12 of 1 year or about 1½ months is not significant.[21] Therefore, it was concluded that for the last owner purchased cows have as long a productive herd life as raised cows. As purchased cows were older than raised cows at disposal, it was also concluded that the total productive life of purchased cows (assuming comparable ages at first freshening for both raised and purchased cows) was significantly longer than for raised cows.

The average herd life of 3.43 years for purchased cows represented only the years in the herd that reported the cow as being removed. The reported herd life as a purchased cow did not include the time the purchased cow spent in the original herd in which she was classed as a raised cow. Therefore, the total productive herd life of the sample of purchased cows was estimated to be 4.87 years. This compares with a total herd life of 3.55 years for raised cows. Some of the difference of 1.32 years additional herd life of purchased cows is related to life expectancy.

Table 11 shows the reported average life expectancy of samples of cows of various ages in New Hampshire, Indiana, Iowa, Kansas, and Florida. The life expectancies are similar in the several states, except for young cows in Iowa. The Iowa records were taken in 1927-28 and 1930-36. Records for the other states were taken in 1949-54. Changes in technology between the two periods may explain the lower figure for Iowa.

Life expectancy declines more slowly as cows grow older. In the New Hampshire sample, a cow exactly 2 years old had an average future lifetime of 4.1 years, or a total life of 6.1 years. But when she reached the age of 6 years, she had not just 0.1 years to live but an average future

Table 11. Life Expectancy of Cows of Various Ages in Samples of Herds in New Hampshire, Kansas, Indiana, Iowa, and Florida[1]

Age	New Hampshire[2]	Kansas[3]	Indiana[4]	Iowa[4]	Florida[5]
Years	Years	Years	Years	Years	Years
2	4.1	4.2	3.6	4.1	4.7
3	3.5	3.6	3.8	3.4	4.0
4	3.2	3.1	3.6	2.9	3.5
5	2.9	2.7	3.3	2.4	3.2
6	2.7	2.5	2.9	2.2	2.9
7	2.5	2.3	2.6	2.1	2.5
8	2.3	2.2	2.2	1.9	2.2
9	2.1	2.1	2.2	1.6	2.1
10	1.9	1.4	1.9	—	1.9
11	1.7	1.8	2.1	—	1.8
12	1.5	1.6	1.6	—	1.5
13	1.3	—	—	—	1.4

[1] The erratic differences in life expectancy at older ages is due to the small number of cases studied. Theoretically, with large numbers of cases the results would be less discrete.

[2] Removal records for 2,135 cows in New Hampshire Dairy Herd Improvement Associations for 1952-54.

[3] Removal records for 8,691 cows in 1950-54. The original data for both New Hampshire and Kansas excluded cows that were removed for dairy purposes and therefore did not fully represent the cow universe.

[4] The Indiana and Iowa statistics were developed from age distribution relationships. In terms of cow-removal records, the Indiana data covers 7,196 cows in 1952. The Iowa sample covers 27,091 cow removals in 1927-28 and 1930-36.

[5] Computed by R. B. Becker, P. T. Dix Arnold, and A. H. Spurlock, *Productive Life-Span of Dairy Cattle*, Fla. Agr. Expt. Sta. Bul. 540, 1954.

[21] Statistical measurements of the age distributions and years in the herd were made using the Chi-square and t tests.

lifetime of 2.7 years. When she reached the age of 9 she had a life expectancy of 2.1 years. Thus a cow bought at the age of 6 would have a life expectancy of 2.7 years while a heifer freshening at the age of 2 would have 4.1 years. The 2-year-old cow could be expected to be in the herd only 1.5 years longer than a 6-year-old. This helps to explain the longer total productive life of purchased cows.

Yields for Hay, Silage Crops, and Pasture

The soils of New England are not particularly noted for their native fertility. A recent study of soil resources states: "Since only small amounts of nutrients are present in the soils in New England, these soils are infertile in their natural state. Although the soils in New England are naturally infertile, they are highly responsive to fertilization."[22] The fact that the infertile soils in New England and in New Hampshire respond to fertilization and good management partly explains much of the variation among farms in yields per acre of forage crops. The most productive soils that are used for cultivated crops hold moisture well during the critical growing seasons.[23] Differences in moisture also account for variations in yields between farms and between and within fields on individual farms.

The average yields for all classes of hay in New Hampshire in 1954, as reported by the Crop Reporting Service, was 1.28 tons per acre.[24] The

Table 12. Effect of Level of Fertilization on Yields of Forage Crops, Experimental Plots, New Hampshire

Crop and Fertilizer Applied per Acre	Plant Nutrients per Acre			Yield per Acre
	Nitrogen	Phosphorus	Potash	
	Pounds	Pounds	Pounds	Tons
Clover-grass[1]				
Check	0	0	0	0.95
134 pounds of muriate of potash	0	0	80	1.52
400 pounds of 20-percent superphosphate and 134 pounds muriate of potash	0	80	80	2.46
125 pounds of ammonium nitrate, 400 pounds of 20-percent superphosphate and 134 pounds muriate of potash	40	80	80	2.89
Alfalfa[2]				
375 pounds of 8-16-16	30	60	60	2.20
750 pounds of 0-16-16	0	120	120	2.45
750 pounds of 4-16-16	30	120	120	2.90
750 pounds of 8-16-16	60	120	120	3.08
1,500 pounds of 4-16-16	60	240	240	3.31

[1] Derived from Table 1, New Hampshire Agr. Expt. Sta. Cir. 74, F. S. Prince, P. T. Blood, and G. P. Percival, *The Response of Clover and Total Forage to Top-Dressing Fertilizers*, 1947.
[2] Derived from Table 5, New Hampshire Agr. Expt. Sta. Cir. 58, F. S. Prince, P. T. Blood, G. P. Percival, and P. N. Scripture, *Fertilizer Needs of Alfalfa on New Hampshire Soils*, 1942.

[22] C. L. W. Swanson, et al., *The Changing Fertility of New England Soils*, Agr. Info. Bul. No. 133, U. S. Department of Agriculture, 1954.

[23] W. H. Lyford and J. C. Craddock, Jr., *Land Use and Soil Relationships of Strafford County, New Hampshire, in 1938-40*, New Hampshire Agr. Expt. Sta. Bul. (In process).

[24] *Crop Production*, Crop Reporting Board, Agricultural Marketing Service, U. S. Dept. of Agriculture, Annual Summary, December, 1954.

reported yields for alfalfa hay and for clover and timothy hay were 2.0 tons and 1.45 tons per acre, respectively. These yields were considerably smaller than those possible under good growth conditions. The higher yields shown in Table 12, which were obtained under experimental conditions, indicate more nearly the possibilities for production of forage with good management and proper fertilization.

A study of the farm records for the sample of 62 farms visited revealed that differences in yields among farms were closely associated with management ability and the pressure of livestock on feed supplies. Yields of hay averaged 1.3 tons per acre on the farms whose operators bought no replacements and 1.5 tons per acre on farms whose operators bought replacements. Average yields of hay equivalent for all harvested forage crops, including corn silage, was 2.1 tons per acre on farms where no replacements were bought and 1.8 tons per acre on farms where replacements were bought. A total of 121 tons of hay equivalent was harvested on farms where no replacements were bought. This compared with 95 tons of hay equivalent harvested on farms whose operators bought replacements.

The farms with no purchased replacements averaged 25 cows and 24 head of young stock. Farms with purchased replacements averaged 25.6 cows and 17.3 head of young stock. The chief difference in total livestock numbers was due to the greater number of replacement young stock carried on the farms with no purchased replacements. Seventy percent of both types of farms did not keep a bull.

Production of harvested forage per cow was 3.1 tons of hay equivalent on the farms where replacements were raised and 2.6 tons on farms where replacements were bought (Table 13). Operators of farms of both types sold or bought hay equivalent. On the average, both types of farms were deficient in hay equivalent and some hay was purchased. Farmers with no purchased replacements bought 6.9 tons of hay equivalent while farmers who bought replacements bought 22.6 tons of hay equivalent. The purchases of harvested forage raised the supplies of hay equivalent available per animal unit to 3.2 tons on farms with no purchased animals and to 3.1 tons per animal unit on farms with some purchased animals.[25]

An attempt was made to judge pasture yields. Pastures were appraised on the basis of their relationship to typical seasonal yields.[26] The monthly carrying capacities of the pasture program were related to the monthly livestock feed requirements on each farm.

Improved pasture occupied 47 percent of the acreage of pasture on farms with no purchased cows and 57 percent on farms with some purchased animals. Improved pasture was differentiated from unimproved pasture on the basis of type of stand and level of yield. In terms of total annual pasture production, both groups of farms had almost enough to meet the needs for feed. Farms on which all replacements were raised had 95 percent of their pasture feed requirements while farms on which cows were bought had 99 percent of their requirements. But all of this pasture feed was not consumed because of the highly seasonal production of pasture forage. Balancing monthly growth of pasture forage and monthly livestock

[25] It is apparent that many dairy farmers in the State buy winter forage, which is generally obtained from nearby fields on idle farms. For further information see W. K. Burkett, *New Hampshire's Idle Farm Land*, N. H. Agr. Expt. Sta. Bul. 399, 1953.

[26] See Appendix Tables 10 and 9 for the pasture questionnaire and the estimated seasonal pasture production yields used as judging standards in this study.

Table 13. Forage-Dairy Cattle Balance on 62 New Hampshire Farms

Item	Unit	Farms with No Purchased Cows	Farms with Some Purchased Cows
Hay equivalent yield per acre	Tons	2.1	1.8
Total hay equivalent harvested per farm	Tons	121	95
Hay equivalent sold per farm	Tons	2.4	3.6
Hay equivalent purchased per farm	Tons	6.9	22.6
Hay equivalent available per farm	Tons	125.5	113.9
Hay equivalent harvested per animal unit	Tons	3.1	2.6
Hay equivalent available per animal unit	Tons	3.2	3.1
Percentage of pasture acreage improved	Pct.	47	57
Percentage of total pasture feed requirements produced but not necessarily harvested because of seasonal growth	Pct.	95	99
Percentage of farms in various pasture classes based on relationship of seasonal yield to feed requirements:			
Surplus pasture	Pct.	5	0
Sufficient pasture	Pct.	5	21
Adequate pasture	Pct.	48	25
Inadequate pasture	Pct.	42	54
Total forage (harvested and pasture) available but not necessarily consumed because of seasonal pasture growth, per animal unit (includes net purchases)	Tons	5.4	5.4
Winter forage available per animal unit assuming pasture deficit (if any) compensated for by feeding cured forage	Tons	2.9	2.8
Percentage of monthly pasture needs provided when monthly growth and livestock requirements are balanced	Pct.	81	85
Total forage consumed per animal unit — available barn forage and pasture forage that can be consumed considering seasonal pasture growth	Tons	5.2	5.0

requirements, farms with no purchased animals provided 81 percent of their pasture feed requirements while farms with purchased replacements provided 85 percent of their requirements. Thus neither of the two types of farms produced enough pasture forage to meet the need for feed.

Farmers who bought some replacements were short of tillable acreage. They averaged 53 acres of forage compared with 58 acres on farms with no purchased animals. This difference in acreage coupled with lower yields per acre of forage forced the purchase of forage. The profitability of this adjustment cannot be tested in this study but it is not necessarily uneconomic. In many areas of the state, standing hay can be bought at a nominal price or obtained merely for the cutting.

Through the purchase of forage, a somewhat superior pasture program, and a smaller number of young stock, operators of the smaller farms who bought some replacements were able to carry a slightly larger number of cows than farmers who bought no replacements. It was estimated that the total hay equivalent fed per animal unit on farms with purchased cows was 5.0 tons per year compared with 5.2 tons on farms with no purchased animals.

Labor Available for Chore Work and Requirements for Cows and Young Stock

The labor forces on the farms with no purchased replacements ranged from 1 to 4 men and averaged 2.2 men who cared for an average of 39 animal units per farm. Thus each farm worker cared for about 18 animal units. The labor forces on the farms with purchased replacements ranged from 1 to 3.3 men and averaged 2.0 men who cared for an average of 36.5 animal units, which was also about 18 animal units per man.

As the labor used to care for dairy herds on the farms whose operators raised all replacements and the labor on farms whose operators bought replacements did not differ significantly, standard labor requirements for cows and young stock were summarized from reports of previous studies in New Hampshire.[27] The summary of labor requirements is shown in Table 14. They represent a reliable relationship between young stock and cow requirements. The indicated level of operation is attained by many dairymen and surpassed by some.

Table 14. Chore Work for Dairy Cattle on New Hampshire Dairy Farms, by Seasons

Kind of Livestock	Man Labor		
	Winter	Summer	Annual
	Hours	Hours	Hours
Cows	45	35	80
Calves, born during winter	15	5	20
Calves, born during summer	5	15	20
Yearlings	7	2	9
Two-year-olds	9	2	11
Young stock, birth to freshening—born during winter	27	13	40
Young stock, birth to freshening—born during summer	17	23	40

Even though there was no apparent difference between the two groups of farms in chore time for comparable work, individual farms in both groups differed considerably because of differences in management and farm facilities. In general, the amount of work a man can accomplish per unit of time is limited by these factors: (1) The farm building arrangement and interior layout; (2) the size, type, location, and condition of the equipment; (3) the methods of performing the work; (4) the location of pasture fields and the method of pasture feeding; and (5) the quality of work desired.[28]

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[27] H. C. Woodworth, C. W. Harris, Jr., and Emil Rauchenstein, *Efficiency Studies in Dairy Farming*, New Hampshire Agr. Expt. Sta. Bul. 275, 1933.

J. C. Holmes, *Chore Travel in Dairy Barns*, N. H. Agr. Expt. Sta. Cir. 72, 1945.

H. C. Woodworth, K. S. Morrow and J. C. Holmes, *Rapid Milking*, N. H. Agr. Expt. Sta. Cir. 76, 1947.

H. C. Woodworth, K. S. Morrow and E. M. Elliott, *The Problem of Slow Milking Cows*. N. H. Agr. Expt. Sta. Cir. 80, 1949.

H. C. Woodworth and K. S. Morrow, *Efficiency in the Dairy Barn*, N. H. Agr. Expt. Sta. Bul. 387, 1951.

[28] W. M. Collins, *Saving Minutes in the Dairy Barn*, Storrs Agr. Expt. Sta. Bul. 503, 1946.

Woodworth showed a difference of as much as 70 percent in the chore time among efficiently operated 40-cow commercial dairies.[29] Angus and Barr appraised the literature dealing with conventional and loose housing of dairy cattle and found the differences shown in Table 15.[30] Cows in loose housing require less time than those in conventional barns for all chores done in the buildings. The ranges in the differences between loose and conventional housing, however, illustrate the effect of management and barn layout on chore time on individual farms.

Table 15. Comparison of Chore Time on Dairy Cows in Loose and in Conventional Housing

Chore	Comparisons[1]	Time in Loose Housing as a Percentage of Time in Conventional Barn		
		Average	Range	
			High	Low
	Number	Percent	Percent	Percent
Milking	10	84	97	62
Feeding	9	80	97	41
Bedding	11	86	175	25
Cleaning	10	80	144	45
All dairy chores[2]	14	79	96	61

[1] By different investigators of each chore in loose and conventional barns.

[2] Measured from the beginning to the end of dairy chores, not the total of milking, feeding, bedding, and cleaning.

Available Barn Space and Utilization by Cows and Heifers

For the sample of dairy farms visited, both those whose operators bought replacements and those whose operators bought no replacements had herds that averaged about 25 cows. The farms with all raised replacements carried an average of 24 head of young stock, including calves. The farms with some purchased replacements had on the average about 17 head of young stock, including calves.

Almost all of the sample dairy farms visited had conventional stanchion-type barns. Fifty-eight farms provided information on conventional stanchion housing. Operators of 34 of the 58 farms bought some replacements while the remaining 24 raised all their replacements. Of the 34 farmers who bought some replacements, only 4 had cows in all the stanchions that were equipped to carry cows. Only 3 of the 24 farmers who raised all their replacements carried the full complement of cows in the stanchions equipped to carry cows. Both groups of farmers had 10 stanchions that could have tied up cows but were in use by young stock, or were idle. The farmers who bought some replacements had 5 cow stanchions used by young stock and 5 idle stanchions. The farmers who bought no replacements had 6 cow stanchions used by young stock and 4 idle stanchions. Table 16 shows the barn space available and the utilization of this space on the sample dairy farms visited.

[29] H. C. Woodworth and K. S. Morrow, *op. cit.*

[30] R. C. Angus and W. L. Barr, "An Apraisal of Research Literature Dealing with Loose and Conventional Dairy Cattle Housing: A Review," Jour. of Dairy Science, Vol. XXXVIII, No. 4, April, 1955.

As can be seen in Table 16, both groups of farms had some barn facilities designed for use only by young stock. The farmers who raised all their replacements had more space and larger investments in barn facilities for young stock than did the farmers who bought some replacements. This latter group had specialized housing facilities for only 14 head of young stock. The farmers who raised all their replacements had specialized facilities for housing 19 head of young stock of various ages.

Table 16. Average Utilization of Barn Space, 34 Farms With Some Purchased Cows and 24 Farms with No Purchased Cows

Type of Stanchion	Utilization of Space			Total Space Available for Use
	Cows	Young Stock	Idle	
	Farms with some purchased cows			
Either cows or young stock	25	5	5	35
Young stock only[1]	—	12	2	14
	Farms with no purchased cows			
Either cows or young stock	25	6	4	35
Young stock only[1]	—	18	1	19

[1] Space used as loose housing for calves or young stock converted to equivalent stanchion space.

Flexibility and Limitations in Use of Resources for Either Cows or Young Stock

The adjustments in cow numbers and numbers of replacements raised or purchased depends largely on the flexibility of the resources. That is, can all the forage be used to carry cows or raise young stock? Can the labor be used equally well to keep cows or young stock? Are the barn facilities such that either cows or young stock can be carried when all the space is used?

Most cured forages whether hay or silage can be used by either cows or young stock. Generally, dairy farmers try to feed what they consider their superior hay or silage to their milking cows. With the possible exception of the very young animals young stock usually get what is, in the farmer's opinion, the poorer forages. These would include hay cut from fields that had predominantly grass stands and hay that had been rained on. Although this type of feed may be inferior relative to other portions of the annual harvested crop, it can be fed to cows as well as to young stock. In fact, based on the proportion of grasses to legumes, many stands of hay fed to cows are relatively inferior. Moreover, much hay consumed by cows has been damaged by rain. Estimates for Connecticut, a rainfall area similar to New Hampshire, indicate that on the average only 34 percent of the field-cured hay is harvested without some damage from rain.[31]

Although in general, cured forage can be used to carry either cows or young stock, pasture is not so flexible. About 70 percent of the New Hampshire dairymen surveyed in connection with this study indicated that they had some pastures they could use only for grazing young stock and in some instances for dry cows. In most instances, the use stipulation

[31] V. E. Ross and I. F. Fellows, *An Economic Evaluation of the Barn-Finishing Method of Harvesting Hay*, Storrs Agr. Expt. Sta. Bul. 277, 1951.

was based on the distance from the farmstead. The distance from the barn to the pasture was such that milking animals could not move, or be economically transported, to and from the pasture. Many of these pastures were rented, and at one time were connected with a producing dairy farm. Burkett studied the renting pattern for the town of Walpole, New Hampshire.[32] Of the 45 active dairy farms, 26, or 58 percent, of their operators rented some land away from the homestead. Moreover, of the 18 farmers who did not rent land, 9 owned some land that was used for crops or

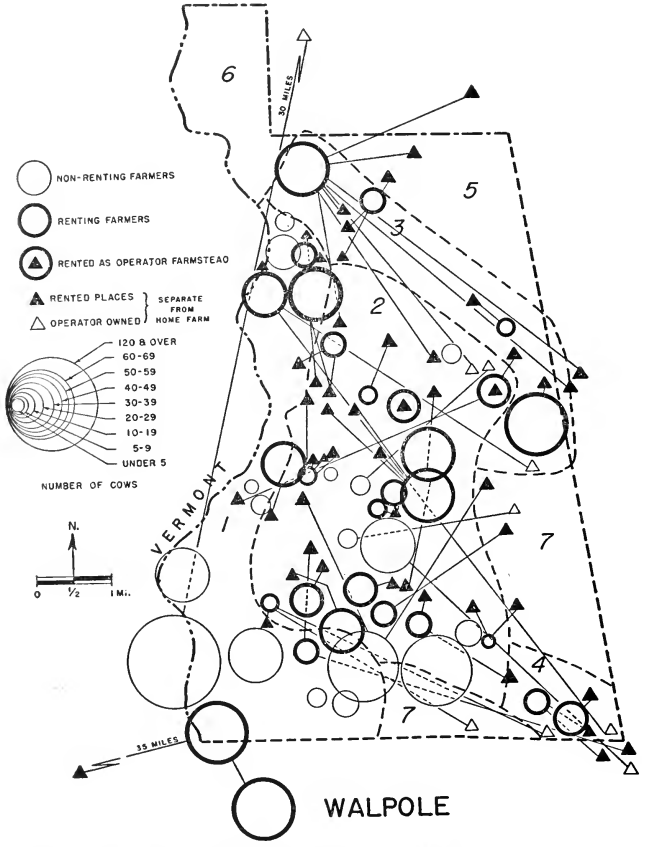

Figure 6. Pattern of renting in the town of Walpole, New Hampshire. Dairy opportunity areas are numbered from 1, the best, to 7, the poorest.[1]

[1] W. K. Burkett, *op. cit.*

[32] W. K. Burkett, *New Hampshire's Idle Farm Land,* N. H. Agr. Expt. Sta. Bul. 399, 1953.

pasture some distance from the home farm (Figure 6). The average distance of the rented or owned pieces of land not contiguous to the home farm was 3.1 miles. One farmer operated a piece of rented land 35 miles distant. The closest rented piece was less than a quarter of a mile distant. Another farmer rented seven pieces of land and owned one piece away from the farm. None of the pieces of land was closer than six-tenths of a mile from this farm and the average distance was 2.5 miles. Of the 51 pieces of land rented by 26 of the farm units, 27 pieces were used for pasture. Thus more than half of the rented places were obtained to be used for pasture. As most of them were a considerable distance from the homestead, they were probably used to carry young stock with perhaps some dry cows included. The relatively high incidence of rented or owned pieces of isolated pastures that can be used only for carrying young stock or dry cows indicates that much permanent-type pasture cannot be used to carry milking cows. Thus for pasture feed in general, it can be concluded that there is flexibility of use for most of the improved pastureland and some of the permanent pasture near the farmstead. However, many permanent-type pastures located at considerable distances from the farmstead are not flexible as to use, in that they can carry only dry cows and young stock.

Most of the 62 farms surveyed had conventional stanchion barns. Only a few had loose-type stabling. For the farms that had the loose or pen-type stables, the space is quite flexible as to use. Usually with a minimum of changing certain movable partitions or gates, the barn space can be used to carry cows or young stock. For the 58 farms for which information was obtained on conventional stanchion housing facilities, only 7 farms had all their cow stanchions filled. The other 51 farms had either empty cow stanchions or young stock tied up in stanchions that could have housed milking cows (Table 16). On the average for the 58 farms, there were about 10 full-sized stanchions that were either empty or used by young stock. Like all cow stanchions these were flexible resources in that they could be used to carry either cows or young stock.

All of the farms visited had some parts of their barn facilities organized as calving, calf rearing, or young stock facilities. Without remodeling, this space could not be used to carry milking animals and was therefore quite inflexible. The barn facilities were such that an average of 16 young stock could be housed on each of the 58 farms that provided records.

Most of the dairy farms surveyed had the type of labor force that could care for milking cows or young stock. However, several farms had some family labor that could not perform all the chores associated with milking. In most instances, these family workers were children or older people. As they could not perform all types of chore work, their labor functions were not completely flexible. But by and large, the labor forces on most of the farms could care for either young stock or milking animals.

A question with respect to labor utilization that is of some concern is how the seasonal distribution of labor requirements are affected by changes in the number of replacements relative to cows. In summer, chore work and crop work compete for the farmer's time. By assuming a constant annual chore workload for a dairy farm, the number of cows and heifers can be varied to answer the question of how and by how much the seasonal labor pattern requirements would differ. For example, using the chore work requirements stated in Table 14, a dairyman who now carries 25 cows and raises all his own replacements could with the same total annual expendi-

ture of chore time carry 29 cows or only raise replacements. If for these alternatives, it is assumed that the freshening pattern is regular or, in the case of the replacement-raising alternative, that the same number of calves are started each month, how and by how much would the seasonal labor pattern differ?

As seen in Table 17, the milking herd with all home-raised replacements uses 43.0 percent of the total annual chore time in summer. With the same total annual workload, but with all replacements purchased, the percent of annual chore time used in summer is increased only slightly to 43.8 percent. It requires a shift with much more emphasis on young stock before any noticeable changes occur in the seasonal workload. Starting 66 calves each year would cut the summer chore work requirements down to 37.5 percent of the annual chore work requirements. This reduction would be of some help in allowing the crop work to be lengthened. However, with the same total annual workload, shifting from raising all replacements to raising none and buying all of them would affect chore time requirements on a seasonal basis very little.

Table 17. Percentage of Annual Chore Time Requirements Used With Various Combinations of Dairy Livestock, Assuming a Fixed Amount of Annual Chore Time.

Livestock Combination	Percentage of Annual Chore Time	
	Winter	Summer
	Percent	Percent
25 cows	48.2	37.5
10 calves	4.3	4.3
9 yearlings	2.7	0.8
5 two-year-olds	1.9	0.4
Total	57.1	43.0
29 cows	56.2	43.8
Total	56.2	43.8
66 calves	28.8	28.8
59 yearlings	18.0	5.2
40 two-year-olds	15.7	3.5
Total	62.5	37.5

Prices Paid and Received

Two levels and relationships of prices paid and received were selected for use in the budgetary analysis. They represent two different price patterns which dairymen have experienced in the recent past. They are also extreme enough to illustrate the production adjustments that could profitably be made by farms in different locations with respect to market and with respect to price level and relationship.[33]

[33] Milk prices are based on the price paid farmers for 3.7 percent milk in the 201-210 mile zone of the Boston milkshed, as published monthly by the Market Administrator, Federal Milk Order No. 4.

Dairy replacement prices are from the monthly milk production report issued by the New England Crop Reporting Service, AMS, U.S.D.A.

Prices for beef cattle and the index of prices were obtained from Crops and Markets, BAE and AMS, and Agricultural Prices, AMS, U.S.D.A.

As shown in Table 18, situation I represents the prices received and paid by dairymen for several major items from 1951 to 1952. During this period, the parity ratio of prices received to prices paid was about 105. As shown in Figure 6, the prices for fluid milk, dairy replacements, and beef were high relative to prices paid for all farm-consumed goods and services when compared with the period 1949-50. During the 1949-50 period, the parity relationship of prices received to prices paid by farmers was equal to 100.

Situation II, shown in Table 18, represents the prices received and paid by dairymen from 1954 to 1955. During this period, the parity ratio of prices received to prices paid was about 88. As shown in Figure 7, the prices for fluid milk, dairy replacements, and beef were low compared with the general level of prices paid relative to 1949-50.

Table 18. Prices Received and Prices Paid for Major Items on Dairy Farms That Influence the Decision of Raising Versus Buying Replacements

Item	Unit	Situation I 1951-1952	Situation II 1954-1955
		Prices Received	
Milk			
Zone mileage[1]			
0-40	Cwt.	$6.10	$5.30
41-80	Cwt.	5.75	5.00
81-120	Cwt.	5.25	4.58
121-160	Cwt.	4.93	4.28
161-200	Cwt.	4.88	4.24
Beef cows	Cwt.	21.90	9.75
Beef calves	Cwt.	28.00	15.25
		Prices Paid	
Milk substitutes	Cwt.	7.00	7.00
Calf starter	Cwt.	4.70	4.50
Fitting ration	Cwt.	4.00	3.80
16 Pct. dairy ration	Cwt.	4.50	4.20
Hay — baled	Ton	30.00	30.00
Breeding	Service	6.00	6.00
Bedding	Bu.	0.02	0.02
Medication	Cow	4.00	4.00
Dairy replacements	Animal	277.00	177.00

[1] See Appendix Table 11 for a complete listing of milk prices as they relate to distance from market for a typical month.

Economic Analysis

THE PURPOSE of this section is to outline how a typical farm may be organized to obtain optimum net income from land, buildings, labor, and working capital, or credit now controlled by the operator. For the present analysis of a method of obtaining dairy herd replacements, the specific question is, should a farmer specialize more in production of milk by raising fewer or no replacements, or should he raise more replacements and thereby produce less milk with his present resources in the form of forage, labor, and building space? That is, what is the most economic combination of cows and young stock for a typical farm situation?

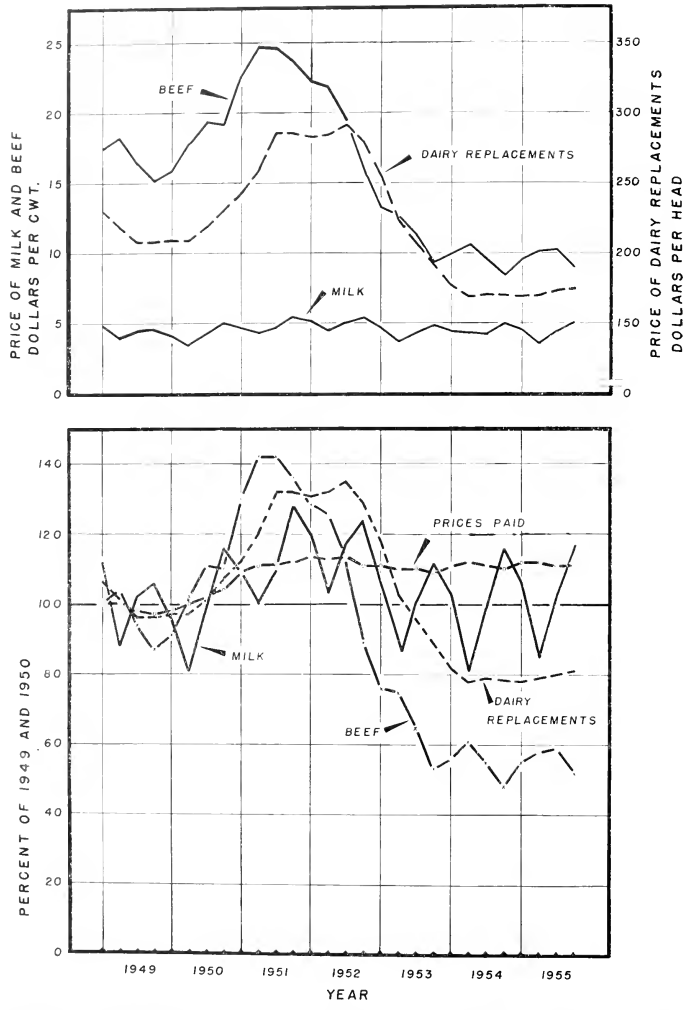

Figure 7. Prices of milk, dairy replacements, and beef, 1949 through 1955, and relationship to level of prices paid by quarters with years 1949 and 1950 equal to 100.

The process by which the information and data in the foregoing sections of this bulletin are combined into an economic analysis of the replacement problem is called a farm budget. A budget for a typical farm measures the effects of changes in the number of replacements raised and the number of cows kept on the net income obtained by the farmer from his farming operations.

Table 19. Production and Utilization of Forage on a Typical Small Dairy Farm on Which All Required Dairy Herd Replacements are Raised, Price Situation I[1]

Crop	Acreage	Production of Hay Equivalent	Utilization of Hay Equivalent			
			Either Young Stock or Milking Cows		Only Young Stock or Dry Cows	
			Grazed Only	Harvested or Grazed	Grazed Only	Harvested or Grazed
	Acres	Tons	Tons	Tons	Tons	Tons
Zone Mileage 0-40						
Hay-pasture	35	84	—	84	—	—
New seeding	9	20	—	20	—	—
Rotation pasture	14	32	32	—	—	—
Permanent pasture	45	36	26	—	10	—
Total	103	172	58	104	10	—
Zone Mileage 41-80						
Hay-pasture	36	86	—	86	—	—
New seeding	9	20	—	20	—	—
Rotation pasture	14	32	32	—	—	—
Permanent pasture	45	36	26	—	10	—
Total	104	174	58	106	10	—
Zone Mileage 81-120						
Hay-pasture	37	89	—	89	—	—
New seeding	9	20	—	20	—	—
Rotation pasture	14	32	32	—	—	—
Permanent pasture	45	36	26	—	10	—
Total	105	177	58	109	10	—
Zone Mileage 121-160						
Hay-pasture	38	91	—	91	—	—
New seeding	10	22	—	22	—	—
Rotation pasture	14	32	32	—	—	—
Permanent pasture	45	36	26	—	10	—
Total	107	181	58	113	10	—
Zone Mileage 161-200						
Hay-pasture	38	91	—	91	—	—
New seeding	10	22	—	22	—	—
Rotation pasture	14	32	32	—	—	—
Permanent pasture	45	36	26	—	10	—
Total	107	181	58	113	10	—

[1] See Appendix Table 12 for the production and utilization of forage under price situation II.

The Typical Dairy Farm

The dairy farm used in the budget analysis was typical of those farms in the sample which raised all the replacements to maintain a herd of 25 cows. The typical farm has a forage-dairy cattle balance that is the same as shown in Table 13 for the sample of dairy farms, except that it produces enough pasture and winter forage to carry all cows and replacements as was done on about a third of the farms in the sample. The possibilities for production and utilization of forage on a typical farm are shown in Table 19. As price relationships differ in the various milk zones,

Table 20. Summary of Types of Physical Information Useful in Making Economic Decisions with Respect to the Replacement Program on Dairy Farms[1]

Item	Unit or Rate	Time Period	Dairy Cows[2] Price Situation I	Price Situation II	Young Stock
Feed inputs					
Milk	Lb.	To calving	——	——	75
Milk substitutes	Lb.	To calving	——	——	50
Grain	Lb.	To calving	——	——	1,200
Zone mileage		Per year			
0-40	Lb.		1,815	1,465	——
41-80	Lb.		1,520	1,250	——
81-120	Lb.		1,215	1,020	——
121-160	Lb.		1,035	885	——
161-200	Lb.		1,000	870	——
Winter forage as hay equivalent	Ton	To calving	——	——	2.8
Zone mileage		Per year			
0-40	Ton		2.7	2.8	——
41-80	Ton		2.9	3.0	——
81-120	Ton		3.1	3.2	——
121-160	Ton		3.3	3.3	——
161-200	Ton		3.4	3.5	——
Pasture as hay equivalent	Ton	To calving	——	——	2.0
Zone mileage		Per year			
0-40	Ton		2.8	2.8	——
41-80	Ton		2.7	2.7	——
81-120	Ton		2.6	2.7	——
121-160	Ton		2.6	2.6	——
161-200	Ton		2.5	2.5	——
Bedding — sawdust	Bu.	Per year	300	300	180
Labor	Hour	Per year	80	80	40
Calves born per cow	No.	Per year	0.93	0.93	——
Herd life					
Raised cows	Year	——	3.5	3.5	——
Purchased cows	Year	——	3.4	3.4	——
Calves of both sexes born dead, dying at birth or within first week	Pct.	——	——	——	11.0
Female young stock that will not die or be culled for disease after first week	Pct.	——	——	——	80.0
Stable space requirements					
Stanchions, animals 1+ years	No.	To calving	1	1	1.3
Area, animals 1+ years	Sq. ft.	To calving	90	90	70

[1] For hay yields see Table 13 and for pasture yields see Appendix Table 9.

[2] Both raised and purchased cows produce at the rate of 8,500 pounds of 3.7 percent milk per year.

the level of grain feeding and consumption of forage vary as the distance from market increases. It was necessary therefore to vary the acreage of forage and grain in relation to the milk price zone. Thus, although the quantities of forage needed to maintain the 25-cow herd and replacements vary with distance to market, production of forage on the farm provides an adequate supply.[34]

The yields of crops per acre on the typical farm are at the level of the average for the highest third of the sample farms visited. Hay-pasture land was assumed to produce 2.4 tons of hay equivalent per acre from both harvested and grazed land. New seedings were assumed to yield 2.2 tons of hay equivalent per acre. Yields of improved rotation pasture were 2.3 tons of hay equivalent per acre and of permanent pasture 0.8 ton per acre. The forage was classified as good. The feeding rates for cows and young stock on the typical farm that are shown in Table 20 were based on the information given in Tables 5 and 6. The length of the pasture season varies with location in the milkshed. This accounts for some of the variation between quantities of winter forage and pasture in Table 20.

The typical farm has a herd of 25 cows and enough young stock to provide all the replacements necessary. The level of production per cow is 8,500 pounds of 3.7 percent milk. The life of a cow in the herd is 3.5 years which means that 7 cows would be culled and 12 calves would be sold from the farm each year (Table 21).

Building space for the typical farm is based on that found on the sample dairy farms visited (Table 16). It is assumed that there are 35 stanchions that can be used for either cows or young stock, and that an equivalent of 11 stanchions can be used only for young stock of various ages (Table 21).

Table 21. Livestock Organization and Barn Space on a Typical Small Dairy Farm Whose Operator Raises All Required Dairy Herd Replacements

Kind of Livestock	Quantity of Livestock	Livestock Sold		Milk Produced
		Cull Cows	Calves	
	Number	Number	Number	Pounds
Cows	25	7		212,500
Heifers, 2 years and over	2			
Heifers, yearlings	8			
Heifer calves	9		12	

Type of Stanchion	Stanchions
	Number
Cow or young stock	35
Young stock only:	
1 year and over	7
Calves[1]	4

[1]Space formerly used as loose housing for calves that would be converted to equivalent stanchion space.

[34] This is the best method of balancing feeds to needs and minimizing the variations in budgeted costs and returns among the various price zones. Differences in income computed in this way more truly represent the effect of location, and therefore prices, on the relative profitability of various combinations of purchased and raised replacements.

The supply of labor for additional chore work on the typical farm is 1,400 man hours. Among the operators who were visited, 85 percent believed that the chore work for additional cows could be done with their present labor force. On the average, they believed they could carry 17 more cows without increasing their labor force. Assuming chore time requirements for dairy cows as shown in Table 14, they would have available about 1,400 man hours a year that could be used to do additional chore work. Many farms in the sample carried 30 cow equivalents or more per man. The highest ratio of cow equivalents to farm workers was 36 to 1. This was double the average for all the farms visited. Therefore, the farmers' estimates that they had enough extra chore-time labor to care for an additional 17 cows per farm appeared to be reliable.

Short-Run Alternatives on the Typical Farm

Within the framework of the typical farm organization, changes were budgeted in the use of forage, barn space, and labor. All resources that could be used to maintain milking animals were budgeted to that use. Hay, pasture, barn space, or labor that were specialized and could not carry milking animals were budgeted to carry replacements. Generally, resources such as hay were bought to balance resources of barn space or labor that might otherwise be left idle. In some circumstances, certain resources were not used to raise replacements or carry cows but were left idle. More specific assumptions were developed for each of the several alternative conditions budgeted in the analysis. The method of partial budget analysis was used throughout to test the change in net farm income associated with changes in use of resources on the typical farm. The prices shown in Table 18 and the physical relationships summarized in Table 20 were used in developing the budgets.

Alternative 1 involves buying all replacements instead of raising them (Tables 22 and 23). There would be enough feed to carry 29 instead of 25 cows. No additional resources would be bought. Some of the specialized resources such as pasture and stanchions that are usable, only by young stock, would be left idle. The shift from raising to buying replacements could be made with no additional capital investment. Under price situation I, farm income would be increased by $160 to $437, depending on the milk price zone (Table 24). Under price situation II, net farm income would be increased by $536 to $796.

As many of the farm resources, particularly building space, labor, and forage are not used under alternative 1, alternatives 2, 3, and 4 were developed to show the effect on farm net income when these resources were more fully employed.

Alternative 2 is based on a shift from 25 cows and raised replacements to 35 cows and all purchased replacements (Tables 22 and 23). By making this shift to 35 cows, the barn space that is capable of carrying cows is fully utilized. However, there are still other unused resources, such as barn space for 11 young stock, 880 man hours of labor, and pasture suitable for young stock only. As there are more total animal units with alternative 2, the need for roughage is increased, and 32 tons of hay equivalent would be bought each year. Additions to net farm income under alternative 2 would be as high as $1,948 under price situation I and $1,894 under price situation II (Table 24). An addition of $720 in capital investment would be needed to buy livestock.

Table 22. Herd Size, Herd Composition, and Resources for a Typical Dairy Farm Shifting from 25 Cows and Raised Replacements to Alternative Herd Sizes and Varying Combinations of Raised and Purchased Replacements, Price Situation I

Milk Zone Mileage and Alternative	Cows in Herd			Annual Replacements		Unused Resources				Purchased Resources	
						Stanchion Equivalents					
	Raised	Purchased	Total	Raised	Purchased	Cows or Young Stock	Young Stock Only	Man-Hours	Pasture as Hay Equivalent	Hay Equivalent	Stanchion Equivalents[1]
	Number	Number	Number	Number	Number	Number	Number	Number	Tons	Tons	Number
0-40 miles											
Original	25	0	25	7	0	2	0	1,400	0	0	0
Alternative 1	0	29	29	0	9	6	11	1,360	10	0	0
Alternative 2	0	35	35	0	10	0	11	880	10	32	0
Alternative 3	14	21	35	4	6	0	0	680	0	46	0
Alternative 4	35	0	35	10	0	0	0	400	0	80	14
41-80 miles											
Original										0	
Alternative 1										0	
Alternative 2					No change					34	
Alternative 3										48	
Alternative 4										82	
81-120 miles											
Original										0	
Alternative 1										0	
Alternative 2					No change					34	
Alternative 3										48	
Alternative 4										82	
121-160 miles											
Original										0	
Alternative 1										0	
Alternative 2					No change					35	
Alternative 3										49	
Alternative 4										83	
161-200 miles											
Original										0	
Alternative 1										0	
Alternative 2					No change					35	
Alternative 3										49	
Alternative 4										83	

[1] Used to raise young stock only.

Table 23. Herd Size, Herd Composition, and Resources, for a Typical Dairy Farm Shifting from 25 Cows and Raised Replacements to Alternative Herd Sizes and Varying Combinations of Raised and Purchased Replacements, Price Situation II

Milk Zone Mileage and Alternative	Cows in Herd			Annual Replacements to Herd		Unused Resources				Purchased Resources	
						Stanchion Equivalents					
	Raised	Purchased	Total	Raised	Purchased	Cows or Young Stock	Young Stock Only	Man-Hours	Pasture as Hay Equivalent	Hay Equivalent	Stanchion Equivalents[1]
	Number	Number	Number	Number	Number	Number	Number	Number	Tons	Tons	Number
0-40 miles											
Original	25	0	25	7	0	2	0	1,400	0	0	0
Alternative 1	0	29	29	0	9	6	11	1,360	10	0	0
Alternative 2	0	35	35	0	10	0	11	880	10	34	0
Alternative 3	14	21	35	4	6	0	0	680	0	48	0
Alternative 4	35	0	35	10	0	0	0	400	0	82	14
41-80 miles											
Original										0	
Alternative 1										0	
Alternative 2					No change					34	
Alternative 3										48	
Alternative 4										82	
81-120 miles											
Original										0	
Alternative 1										0	
Alternative 2					No change					35	
Alternative 3										49	
Alternative 4										83	
121-160 miles											
Original										0	
Alternative 1										0	
Alternative 2					No change					35	
Alternative 3										49	
Alternative 4										83	
161-200 miles											
Original										0	
Alternative 1										0	
Alternative 2					No change					36	
Alternative 3										50	
Alternative 4										84	

[1] Used to raise young stock only.

Table 24. Additional Investment and Net Farm Income Possible for a Typical Dairy Farm by Shifting from 25 Cows and Raised Replacements to Alternative Herd Sizes and Varying Combinations of Raised and Purchased Replacements for Both Price Situations

Milk Zone Mileage and Alternative	Price Situation I			Price Situation II		
	Price of Milk per Hundredweight	Additional Capital Investment	Additional Net Farm Income	Price of Milk per Hundredweight	Additional Capital Investment	Additional Net Farm Income
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
0-40 miles	6.10			5.30		
Original		0	0		0	0
1		0	437		0	796
2		1,120	1,948		720	1,894
3		1,970	2,222		1,260	1,803
4		4,620	2,156		3,385	1,195
41-80 miles	5.75			5.00		
Original		0	0		0	0
1		0	368		0	738
2		1,120	1,750		720	1,736
3		1,970	1,995		1,260	1,641
4		4,620	1,931		3,385	1,030
81-120 miles	5.27			4.58		
Original		0	0		0	0
1		0	256		0	631
2		1,120	1,473		720	1,443
3		1,970	1,720		1,260	1,350
4		4,620	1,658		3,385	742
121-160 miles	4.93			4.28		
Original		0	0		0	0
1		0	172		0	548
2		1,120	1,236		720	1,241
3		1,970	1,484		1,260	1,149
4		4,620	1,424		3,385	598
161-200 miles	4.88			4.24		
Original		0	0		0	0
1		0	160		0	536
2		1,120	1,206		720	1,181
3		1,970	1,454		1,260	1,089
4		4,620	1,394		3,385	483

Alternative 3 calls for raising some and buying some of the dairy herd replacements. The herd composition, as shown in Tables 22 and 23, for the two price situations is 14 raised cows and 21 purchased cows. Enough replacements would be raised to utilize fully the specialized housing facilities and pasture available for use by young stock only. Each year, 4 replacements would be raised and 6 would be bought. The labor force still would not be fully employed. However, to carry the additional livestock, the operator would need to buy 48 tons of hay equivalent annually. Under price situation I, additional net farm income would be increased considerably above that received originally and under alternatives 1 and 2 (Table 24). For price situation II, income under alternative 3 would exceed the original and alternative 1 but would be about equal to that from alternative 2.

Alternative 4. The typical dairy farm has many resources that were underemployed at the time of the study. With 25 cows and raised replacements, some building space and some labor were not used. An increase in the number of cows from 25 to 35 produced considerable additional net

farm income. Therefore, alternative 4 was developed to show a better comparison between the alternative methods of providing replacements. It shows the changes in income associated with shifting to 35 cows and all home-raised replacements. To carry the herd of 35 cows and raise all the replacements, some additional building space for raising young stock was needed. Considerable hay had to be bought, the quantities depending on the price situation as shown in Tables 22 and 23. By adding building space and livestock, considerable additional capital investment would be required under both price situations. Under price situation I, alternative 4 would not be as profitable as alternative 3, but it would be more profitable than alternatives 1 and 2 (Table 24). With price situation II, however, alternative 4 would not be as profitable as alternatives 2 and 3, but it would be more profitable than alternative 1 and the original farm organization.

To summarize briefly, the typical dairy farm has building space and labor that is not fully utilized. Alternative 1, which was a shift from 25 cows and raised replacements to 29 cows and purchased replacements, required no additional capital investment. About the same number of hours of labor per year was required to operate the crop and livestock enterprise. Yet, with no basic changes in the farm structure other than the shift in the source of replacements, net farm income would be increased considerably. Alternatives 2, 3, and 4 involved varying amounts of additional forage, capital investment, and work on livestock. In general, these alternative methods of operation produced greater increases in net income than alternative 1. But it should be observed that on a typical dairy farm under some price relationships, it may be as profitable to leave some farm resources idle as to invest additional capital so that all of some specialized resources can be used.

Long-Run Adjustments on a Typical Farm

On a short-run basis, many farm resources are inflexible in their use. Over longer periods of time, however, barn space is remodeled, new barns are built, land holdings are changed, and land use is varied. In view of this, a series of farm budgets was developed, based on the assumption of long-run flexibility in the resources on the typical farm. When resources are flexible and can be used to carry either young stock or cows, many problems encountered in developing alternative farm plans for the typical dairy farm are eliminated.

It was also assumed that in the long run there were no unused or idle resources in the typical farm situation. Thus in Table 25 with a 35-cow herd that raised 10 replacements annually, there were no unused man hours of labor, forage, or barn space.[35] Based on the rates of substitution of these resources from young stock to cows, 40 cows could be carried if 12 replacements were bought each year. As labor was substituted at the highest rate, shifting from 35 to 40 cows would leave 2 stanchions idle and an annual surplus of 20 tons of hay equivalent in the 0-to 40-mile zone (Table 25). As the distance from market increased, the quantity of unused forage would decrease. The unused barn space was left idle and the forage was sold.

[35] The herd size, herd composition, and resources for a dairy farm with flexible farm resources under price situation I are shown in Appendix Table 13.

Table 25. Size and Composition of Herd and Resources Unused or Sold for a Dairy Farm with Flexible Farm Resources That Shift from 35 Cows and Raised Replacements to 40 Cows and Purchased Replacements, Situation II

Milk Zone Mileage and Alternative Farm Plan	Cows in Herd			Annual Replacements to Herd		Unused Equivalents				Hay Equivalent Sold
						Stanchion Equivalents				
	Raised	Purchased	Total	Raised	Purchased	Cows or Young Stock	Young Stock Only	Man-hours	Pasture as Hay Equivalent	
	Number	Number	Number	Number	Number	Number	Number	Number	Tons	Tons
0-40 miles										
35 cows	35	0	35	10	0	0	0	0	0	0
40 cows	0	40	40	0	12	2	0	0	20	20
41-80 miles										
35 cows									0	0
40 cows				No change					20	20
81-120 miles										
35 cows									0	0
40 cows				No change					18	18
121-160 miles										
35 cows									0	0
40 cows				No change					18	18
161-200 miles										
35 cows									0	0
40 cows				No change					18	18

The additional net farm income made possible by shifting from 35 cows and raised replacements to 40 cows and purchased replacements under price situation II is shown in Table 26.[36] This comparison also answers two additional questions associated with shifting from raising to buying replacements. First, the adjustment can be made without the use of credit. Second, the adjustment from raising to buying replacements can be profitable at the several milk price relationships under price situation II, either by selling young stock under 18 months of age at the beginning of the first year of adjustment or by raising all the young stock on hand at the end of the base year.[37] The additional net farm income represents income above the additional cost of purchased replacements. Thus with alternative A and a milk price of $5.30 per hundredweight, the accumulated additional net farm income would be $6,410 in the first 4 years of adjustment. The additional net farm income with alternative A was greater than with alternative B. In other words, a rapid shift would result in a greater increase in net income.

Effects of Various Price Relationships and Levels of Milk Production on Income from Six Sizes of Herds

To further test the opportunities for profitable adjustments, budgets were developed for farms ranging from milking herds of 11 to 52 cows grouped in 6 size classifications. In the basic budget with which alternatives were compared, price situations I and II were used and production per cow as assumed to be 8,500 pounds of milk.

In the first phase of this part of the analysis, the break-even prices for milk, replacements, and cull cows and calves were computed separately.

Table 26. Additional Net Farm Income Possible on Dairy Farms with Flexible Farm Resources by Shifting from 35 Cows and Raised Replacements to 40 Cows and Purchased Replacements, Price Situation II

Milk Zone Mileage	Price of Milk per Hundredweight	Additional Net Farm Income by Years After Adjustment						
		Base Year	1	2	3	4	5 or more	Total for Years 1 - 4
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Alternative A — Sell young stock under 18 months of age at beginning of year								
0- 40	5.30	0	1,976	1,478	1,478	1,478	Same	6,410
41- 80	5.00	0	1,859	1,391	1,391	1,391	Same	6,032
81-120	4.58	0	1,695	1,197	1,197	1,197	Same	5,286
121-160	4.28	0	1,593	1,095	1,095	1,095	Same	4,878
161-200	4.24	0	1,578	1,080	1,080	1,080	Same	4,818
Alternative B — Raise all young stock on hand at end of base year								
0- 40	5.30	0	604	2,071	1,087	1,478	Same	5,240
41- 80	5.00	0	583	2,013	1,000	1,391	Same	4,987
81-120	4.58	0	553	1,901	806	1,197	Same	4,457
121-160	4.28	0	531	1,839	704	1,095	Same	4,169
161-200	4.24	0	528	1,828	689	1,080	Same	4,125

[36] The income possibilities with price situation I are shown in Appendix Table 14.
[37] It is also profitable to shift from raising to buying replacements under price situation I, Appendix Table 14.

At the break-even prices, a dairyman would be indifferent as to whether he raised or bought replacements. The effects of higher prices were also computed.

If all prices paid and received, except milk, were at situation I level, the break-even price for milk would be $2.65 per hundredweight for each of the six sizes of dairy farms. But if the price were $6 per hundredweight for milk, the farm with 11 to 17 cows would have an additional net farm income of $350 while the farm with 46 to 52 cows would have an additional net farm income of $1,330. The net effect of changes in the price of milk on additional net farm income is shown for price situation I in Table 27.

Table 27. Net Effect of Changes in the Price of Milk on Additional Net Farm Income Possible on Dairy Farms with Flexible Farm Resources by Shifting from Raising to Buying Replacements for Farms of Various Sizes, Price Situation I[1]

Price of Milk per Hundredweight[2]	Change in Net Farm Income: Number of Milking Cows in Herd					
	11-17	18-24	25-31	32-38	39-45	46-52
Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
2.00	—60	—100	—140	—175	—215	—250
2.50	—10	—25	—35	—40	—50	—55
3.00	40	55	75	100	120	140
3.50	90	135	185	235	285	340
4.00	140	215	295	370	455	535
4.50	195	300	405	510	625	735
5.00	245	380	515	650	790	930
5.50	295	460	625	790	960	1,130
6.00	350	545	740	935	1,130	1,330
6.50	400	625	850	1,070	1,300	1,530

[1] All prices paid and received, except those for milk, stay at levels consistent with the assumptions of price Situation I.
[2] Break-even price about $2.65 per hundredweight.

The net effect of changes in the price of milk on additional net farm income for price situation II is shown in Appendix Table 15. The break-even price is about $.75 per hundredweight. Thus at a price of $.75 per hundredweight for milk, it would be a matter of indifference to the farmer in any of the six size groups whether they raised or bought replacements.

The effects on net income of changes in the price of replacements under price situation I is shown in Table 28. The break-even price was $363 per head of replacements for farms of all sizes. Thus, if the price of replacements reached $363, no additional income would be realized by shifting from raising to buying replacements. However, if the price of replacements were $200, the additional net farm income that could be obtained by shifting from raising to buying replacements on the farm with 11 to 17 cows would be $695; and for the farm with 46 to 52 cows, the additions to net farm income would be $2,650. If the price of a replacement was $450, the 11- to 17-cow farm would lose $370 by the shift from raising to buying replacements and the 46- and 52-cow farm would lose $1,390 per year.

Under price situation II, the break-even price per head of replacements was $312 (Appendix Table 16). For the 11- to 17-cow farm, if the price paid for replacements rose as high as $400, net farm income

Table 28. Net Effect of Changes in the Price of Replacements on Additional Net Farm Income Possible on Dairy Farms with Flexible Farm Resources by Shifting from Raising to Buying Replacements for Farms of Various Sizes, Price Situation I[1]

Price of Replacements[2]	Change in Net Farm Income: Number of Milking Cows in Herd					
	11-17	18-24	25-31	32-38	39-45	46-52
Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
150	910	1,410	1,910	2,410	2,930	3,450
200	695	1,080	1,460	1,850	2,250	2,650
250	480	750	1,015	1,280	1,560	1,840
300	265	420	570	710	860	1,030
350	55	90	120	145	180	220
400	—155	—240	—330	—415	—500	—590
450	—370	—570	—770	—980	—1,190	—1,390

[1] All prices paid and received, except those for replacements stay at levels consistent with the assumptions of price situation I with milk priced at the level of the 0 to 40 mile zone.
[2] Break-even price about $363 per replacement.

would be reduced by $410 per year by shifting from raising to buying replacements. However, if the price paid for replacements averaged $200, net farm income would be increased by $515 per year for the 11- to 17-cow farm.

The net effect on net farm income of changes in the price of cull cows and veal calves is not as important as changes in the price of milk or of replacements (Table 29). For example, if the prices of culled cows and veal calves were $10 and $15.75 per hundredweight, respectively, a shift to $20 and $26.75 per hundredweight, respectively, would increase net farm income on the 11- to 17-cow farm only $115 under price situation I. The effect under price situation II is shown in Appendix Table 17.

Whereas in the analysis summarized in Tables 27, 28, and 29, the price of only one product varied, the next step in the analysis, which is summarized in Tables 30 through 35, shows additional net income for 2 levels of price of cull cows, 4 levels of price of milk, 5 levels of price of replacements, and 3 levels of production of milk per cow. Prices of other products are assumed to be the same as under price situation II.

Table 29. Net Effect of Changes in the Price of Cull Cows and Calves on Additional Net Farm Income Possible on Dairy Farms with Flexible Farm Resources by Shifting from Raising to Buying Replacements for Farms of Various Sizes, Situation I[1]

Price of:		Change in Net Farm Income: Number of Milking Cows in Herd					
Cull Cows	Veal Calves	11-17	18-24	25-31	32-38	39-45	46-52
Dollars		Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
5.00	10.00	155	255	350	445	545	645
10.00	15.75	220	345	470	600	730	860
15.00	21.25	275	435	595	750	915	1,075
20.00	26.75	335	520	715	900	1,095	1,285
25.00	32.50	395	610	835	1,050	1,275	1,500

[1] All prices paid and received, except those for beef and veal, stay at levels consistent with the assumptions of price Situation I.

In general, for all size groups of farms, the greatest advantage in net farm income gained by shifting from raising to buying all replacements would be obtained with a combination of high prices of cull cows, high prices of milk, low prices of replacements, and a high level of milk production per cow (Tables 30 to 35). With prices of milk at $6 per hundredweight; cull cows $20 per hundredweight; replacements $150 per cow; and production at 10,000 pounds of milk per cow, additional net incomes would vary from $1,035 on the 11- to 17-cow dairy farms to $3,755 on the 46- to 52-cow farms. The greatest loss in terms of change in income resulting from a shift from raising to buying replacements would occur with prices as follows: milk at $3 per hundredweight; cull cows at $10 per hundredweight; and replacements at $350 per animal; and with production of milk at 7,000 pounds per cow. Under these conditions for the 11- to 17-cow size group, the loss incurred by a shift from raising to buying replacements is $605; for the group of farms with 46- to 52 cows, the loss is $2,090 per year.

With this series of tables for various farm size groups (Tables 30 through 35), estimates can be made of the probable change in farm income that is associated with a series of prices received and prices paid for several important items. For example, assume that the farm falls into the size group of 25 to 31 cows, for which the estimates of net farm income are given in Table 32. If the price of milk is $5 per hundredweight, the price of cull cows is $10 per hundredweight, and production of milk per cow is 10,000 pounds per year, a dairyman can estimate the range in changes in income that might be expected at several levels of prices for replacements. That is, if he could buy replacement cows for as little as $150 per head, shifting from raising to buying his replacements would result in an increase in net farm income of about $1,600 a year. With constant prices of milk and cull cows and a constant production per cow, shifting from raising to buying replacements would result in higher net farm incomes until the dairyman pays between $300 and $350 per head of replacements. If he pays as much as $350 per head, he will have a net loss of $185 per year. However, at $300, he would have a net gain of $270 per year. Therefore, the break-even price per replacement is between $300 and $350 when the price of milk is $5 per hundredweight; cull cows, $10 per hundredweight; and when production of milk is 10,000 pounds per cow.

Table 30. Effect on Net Farm Income of Changes in the Prices of Milk, Beef, and Replacements Possible with Flexible Resources by Shifting from Raising to Purchasing Replacements for Farms with 11 to 17 Cows at Three Levels of Milk Production per Cow[1]

Price of Milk per cwt.	Price of Dairy Replacements														
	$150			$200			$250			$300			$350		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Beef price $10 per hundredweight[2]															
$3.00	315	400	485	85	170	255	—145	—60	25	—375	—290	—205	—605	—520	—435
4.00	425	530	640	195	300	410	—35	70	180	—265	—160	—50	—495	—390	—280
5.00	565	695	830	335	465	600	105	235	370	—125	5	140	—355	—225	—90
6.00	650	800	950	420	570	720	190	340	490	—40	110	260	—270	—120	30
Beef price $20 per hundredweight[2]															
3.00	450	535	620	220	305	390	—10	—75	160	—240	—155	—70	—470	—385	—300
4.00	560	665	775	330	435	545	100	205	315	—130	—25	85	—360	—255	—145
5.00	700	830	965	470	600	735	240	370	505	10	140	275	—220	—90	45
6.00	785	935	1,085	555	705	855	325	475	625	95	245	395	—135	15	165

[1] In this study, the basic production level was assumed to be 8,500 pounds of milk per cow. For comparison purposes for level I assume 7,000 pounds; II, 8,500 pounds; and, III, 10,000 pounds of milk per cow.

[2] When beef is $10 per hundredweight, veal is $15.75 per hundredweight. When beef is $20 per hundredweight, veal is $26.75 per hundredweight. Grain prices are those that occur in price situation II.

Table 31. Effect on Net Farm Income of Changes in the Prices of Milk, Beef, and Replacements Possible with Flexible Resources by Shifting from Raising to Purchasing Replacements for Farms with 18 to 24 Cows at Three Levels of Milk Production per Cow[1]

Price of Milk per cwt.	Price of Dairy Replacements														
	$150			$200			$250			$300			$350		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
	Beef price $10 per hundredweight[2]														
$3.00	485	610	740	140	265	395	—205	—80	50	—550	—425	—295	—895	—770	—610
4.00	645	805	965	300	460	620	—45	115	275	—390	—230	—70	—735	—575	—415
5.00	845	1,040	1,235	500	695	890	155	350	545	—190	5	200	—535	—340	—145
6.00	965	1,190	1,415	620	845	1,070	275	500	725	—70	155	380	—415	—190	35
	Beef price $20 per hundredweight[2]														
3.00	680	810	935	335	465	590	—10	120	245	—355	—225	—100	—700	—570	—445
4.00	845	1,005	1,165	500	660	820	155	315	475	—190	—30	130	—535	—375	—215
5.00	1,040	1,235	1,435	695	890	1,090	350	545	745	5	200	400	—340	—145	55
6.00	1,165	1,390	1,615	820	1,045	1,270	475	700	925	130	355	580	—215	10	235

[1] In this study, the basic production level was assumed to be 8,500 pounds of milk per cow. For comparison purposes for level I assume 7,000 pounds; II, 8,500 pounds; and, III, 10,000 pounds of milk per cow.

[2] When beef is $10 per hundredweight, veal is $15.75 per hundredweight. When beef is $20 per hundredweight, veal is $26.75 per hundredweight. Grain prices are those that occur in price situation II.

Table 32. Effect on Net Farm Income of Changes in the Prices of Milk, Beef, and Replacements Possible with Flexible Resources by Shifting from Raising to Purchasing Replacements for Farms with 25 to 31 Cows at Three Levels of Milk Production per Cow[1]

Price of Milk per cwt.	Price of Dairy Replacements														
	$150			$200			$250			$300			$350		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
	Beef price $10 per hundredweight[2]														
$3.00	640	805	980	185	350	525	—270	—105	70	—725	—560	—385	—1,180	—1,015	—840
4.00	885	1,095	1,315	430	640	860	—25	185	405	—480	—270	—50	—935	—725	—505
5.00	1,110	1,370	1,635	655	915	1,180	200	460	725	—255	5	270	—710	—450	—185
6.00	1,305	1,605	1,905	850	1,150	1,450	395	695	995	—60	240	540	—515	—215	85
	Beef price $20 per hundredweight[2]														
3.00	900	1,065	1,240	445	610	785	—10	155	330	—465	—300	—125	—920	—755	—580
4.00	1,145	1,355	1,570	690	900	1,115	235	445	660	—220	—10	205	—675	—465	—250
5.00	1,370	1,630	1,890	915	1,175	1,435	460	720	980	5	265	525	—450	—190	70
6.00	1,560	1,860	2,160	1,105	1,405	1,705	650	950	1,250	195	495	795	—260	40	340

[1] In this study, the basic production level was assumed to be 8,500 pounds of milk per cow. For comparison purposes for level I assume 7,000 pounds; II, 8,500 pounds; and, III, 10,000 pounds of milk per cow.

[2] When beef is $10 per hundredweight, veal is $15.75 per hundredweight. When beef is $20 per hundredweight, veal is $26.75 per hundredweight. Grain prices are those that occur in price situation II.

Table 33. Effect on Net Farm Income of Changes in the Prices of Milk, Beef, and Replacements Possible with Flexible Resources by Shifting from Raising to Purchasing Replacements for Farms with 32 to 38 Cows at Three Levels of Milk Production per Cow[1]

Price of Milk per cwt.	Price of Dairy Replacements														
	$150			$200			$250			$300			$350		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Beef price $10 per hundredweight[2]															
$3.00	760	970	1,185	190	400	615	—380	—170	45	—950	—740	—525	—1,520	—1,310	—1,095
4.00	1,060	1,325	1,595	490	755	1,025	—80	185	455	—650	—385	—115	—1,220	—955	—685
5.00	1,370	1,695	2,025	800	1,125	1,455	230	555	885	—340	—15	315	—910	—585	—255
6.00	1,605	1,980	2,355	1,035	1,410	1,785	465	840	1,215	—105	270	645	—675	—300	75
Beef price $20 per hundredweight[2]															
3.00	1,075	1,285	1,500	505	715	930	—65	145	360	—635	—425	—210	—1,205	—995	—780
4.00	1,375	1,640	1,910	805	1,070	1,340	235	500	770	—335	—70	200	—905	—640	—370
5.00	1,685	2,010	2,340	1,115	1,440	1,770	545	870	1,200	—25	300	630	—595	—270	60
6.00	1,920	2,295	2,670	1,350	1,725	2,100	780	1,155	1,530	210	585	960	—360	15	390

[1] In this study, the basic production level was assumed to be 8,500 pounds of milk per cow. For comparison purposes for level I assume 7,000 pounds; II, 8,500 pounds; and, III, 10,000 pounds of milk per cow.

[2] When beef is $10 per hundredweight, veal is $15.75 per hundredweight. When beef is $20 per hundredweight, veal is $26.75 per hundredweight. Grain prices are those that occur in price situation II.

Table 34. Effect on Net Farm Income of Changes in the Prices of Milk, Beef, and Replacements Possible with Flexible Resources by Shifting from Raising to Purchasing Replacements for Farms with 39 to 45 Cows at Three Levels of Milk Production per Cow[1]

Price of Milk per cwt.	Price of Dairy Replacements														
	$150			$200			$250			$300			$350		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Beef price $10 per hundredweight[2]															
$3.00	940	1,195	1,450	255	510	765	—430	—175	80	—1,115	—860	—605	—1,800	—1,545	—1,290
4.00	1,295	1,615	1,940	610	930	1,255	—75	245	570	—760	—440	—115	—1,445	—1,125	—800
5.00	1,660	2,050	2,450	975	1,365	1,765	290	680	1,080	—395	—5	395	—1,080	—690	—290
6.00	1,940	2,390	2,840	1,255	1,705	2,155	570	1,020	1,470	—115	335	785	—800	—350	100
Beef price $20 per hundredweight[2]															
3.00	1,325	1,580	1,835	640	895	1,150	—45	210	465	—730	—475	—220	—1,415	—1,160	—905
4.00	1,680	2,000	2,325	995	1,315	1,640	310	630	955	—375	—55	270	—1,060	—740	—415
5.00	2,045	2,435	2,835	1,360	1,750	2,150	675	1,065	1,465	—10	380	780	—695	—305	95
6.00	2,325	2,775	3,225	1,640	2,090	2,540	955	1,405	1,855	270	720	1,170	—415	35	485

[1] In this study, the basic production level was assumed to be 8,500 pounds of milk per cow. For comparison purposes for level I assume 7,000 pounds; II, 8,500 pounds; and, III, 10,000 pounds of milk per cow.

[2] When beef is $10 per hundredweight, veal is $15.75 per hundredweight. When beef is $20 per hundredweight, veal is $26.75 per hundredweight. Grain prices are those that occur in price situation II.

Table 35. Effect on Net Farm Income of Changes in the Prices of Milk, Beef, and Replacements Possible with Flexible Resources by Shifting from Raising to Purchasing Replacements for Farms with 46 to 52 Cows at Three Levels of Milk Production per Cow[1]

Price of Milk per cwt.	Price of Dairy Replacements														
	$150			$200			$250			$300			$350		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Beef price $10 per hundredweight[2]															
$3.00	1,110	1,400	1,705	310	600	905	—490	—200	105	—1,290	—1,000	—700	—2,090	—1,800	—1,500
4.00	1,515	1,890	2,265	715	1,090	1,465	—85	290	665	—885	—515	—135	—1,685	—1,315	—935
5.00	1,940	2,395	2,855	1,140	1,595	2,055	340	795	1,255	—460	—5	455	—1,260	—805	—345
6.00	2,255	2,780	3,305	1,455	1,980	2,505	655	1,180	1,705	—145	380	905	—945	—420	105
Beef price $20 per hundredweight[2]															
3.00	1,555	1,850	2,150	755	1,050	1,350	—45	250	550	—845	—550	—250	—1,645	—1,350	—1,050
4.00	1,965	2,335	2,715	1,165	1,535	1,915	365	735	1,115	—435	—65	315	—1,235	—865	—490
5.00	2,385	2,840	3,305	1,585	2,040	2,505	785	1,240	1,705	—15	440	905	—815	—360	105
6.00	2,705	3,230	3,755	1,905	2,430	2,960	1,105	1,630	2,155	305	830	1,355	—500	—30	555

[1] In this study, the basic production level was assumed to be 8,500 pounds of milk per cow. For comparison purposes for level I assume 7,000 pounds; II, 8,500 pounds; and, III, 10,000 pounds of milk per cow.

[2] When beef is $10 per hundredweight, veal is $15.75 per hundredweight. When beef is $20 per hundredweight, veal is $26.75 per hundredweight. Grain prices are those that occur in price situation II.

Conclusions

IT IS OFTEN argued in New England that a program of raising all replacements for the dairy herd is better than buying some or all replacements for two reasons. First, purchased replacements are thought to be inferior to home-raised replacements relative to risk of disease, herd life, and milk production. The second traditional argument in favor of a program of raising replacements is that it is cheaper and thus leads to optimum profits.

Based on the sources of physical data in this study, apparently there is no great difference in herd life, disease control, or levels of production between raised and purchased cows. Under certain price relationships, New England dairymen can specialize further and can utilize their resources more economically. Under some conditions, the raising of dairy-herd replacements by individual farmers does not represent the best use of individual farm resources for the development of the New England dairy economy.

When certain inflexibilities in resources were considered, profits generally would have been increased if the operator of a typical dairy farm had shifted from raising to buying replacements. In general, it pays to carry as many cows as possible regardless of the effect on numbers of replacements raised. Individual farm situations determine whether the residual inflexible resources should be used to raise replacements. In most instances, they should be. The problem of inflexibility in resources is important in the short run. The physical production relationships provided in this bulletin can be used by indivdual farmers to determine the profitability of using these resources.

In the long run, most resources on New England dairy farms are flexible as to use, and dairymen would find it economically advantageous to shift from raising to buying replacements within the framework of current prices and technology. A major change in the relationship between prices of replacements and prices of milk would probably result, however, if the demand for replacements increased because a large number of dairymen stopped raising replacements. It may be that the price of replacements has been low historically in New England because many farmers believed that raised replacements were cheaper and better.

A trend on New England dairy farms toward specialization in production of milk and purchase of replacements, together with the historical downward trend in the number of dairy farms, may offer new opportunities on the farms that are forced out of commercial milk production. Many of the farm resources that are forced out of milk production by recent innovations in methods of handling milk and the trend toward higher capitalization are of a quality that could be used to raise replacements. Many of these resources are combined in small units that are not suited to commercial specialization in the raising of replacements, but they could be used to carry and raise young stock for commercial dairymen. A profitable solution would be for individual farmers to contract to have their heifers raised by part-time farmers and returned to them upon maturity as replacements to their dairy herds.

Appendix

Appendix Table 1. Relative Importance of Various Reasons for Removal of Cows from Herds in Dairy Herd Improvement Associations in New Hampshire and Other States

State	Year	Cows in Sample	Reason for Removal							
			Low Production	Dairy Purposes	Udder Trouble	Brucellosis	Sterility	Accidents	Death	Other Reasons
		Number	Percent							
Minnesota[1]	1952	7,586	33.5	18.6	11.7	3.3	14.5	2.6	5.7	10.1
New York[2]	1946	5,329	22.6	27.6	15.9	2.0	11.3	3.8	4.0	12.8
Iowa[3]	1950-53	26,506	33.9	22.5	10.3	1.6	10.7	1.3	5.7	14.0
Kansas[4]	1950-54	11,913	32.3	26.2	14.0	1.0	6.8	1.9	6.3	11.5
New Hampshire	1952-54	3,078	27.9	30.6	13.0	.9	14.6	2.1	3.3	7.6
Total of 17 states[5]	1932-49	611,489	33.5	23.5	11.5	7.3	8.2	—	5.0	11.0

[1] H. R. Searles, Extension Dairyman, University of Minnesota, Contained in letter.

[2] *Why Cows Leave Home*, Cornell Cooperative Extension Service, (Mimeograph), 1947.

[3] *Turnover of Cows in DHIA Herds*, Iowa Cooperative Extension Service, (Mimeograph), 1950-53.

[4] R. Bonewitz, Dairy News Letter, Kansas State Cooperative Extension Service, (Monthly Mimeograph), 1950-54.

[5] S. A. Asdell, "Variation in Amount of Culling From D.H.I.A. Herds," Journal of Dairy Science, Vol. XXXIV, No. 6, 1951.

Appendix Table 2. Number and Proportion of Raised Cows that Were Removed from New Hampshire Dairy Herd Improvement Association Herds, by Age and Reason for Removal, 1952-54

Age at Disposal (Years)	Dairy Purposes		Low Production		Udder Trouble		Brucellosis		Sterility		Accidents		Death		Other Reasons		All Reasons	
	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.
1.5- 2.4	27	3.5	33	5.0	9	3.1	–	—	1	.3	2	4.3	4	5.4	10	6.2	86	3.7
2.5- 3.4	173	22.6	164	24.7	34	11.6	2	11.8	43	13.2	8	17.0	5	6.8	20	12.3	449	19.1
3.5- 4.4	163	21.3	165	24.9	37	12.7	3	17.6	57	17.5	5	10.6	12	16.2	22	13.7	464	19.8
4.5- 5.4	144	18.8	109	16.4	42	14.4	2	11.8	52	16.0	7	14.9	13	17.5	22	13.7	391	16.6
5.5- 6.4	94	12.3	61	9.2	35	12.0	2	11.8	46	14.1	6	12.8	11	14.9	18	11.1	273	11.6
6.5- 7.4	70	9.1	52	7.8	33	11.3	3	17.6	41	12.6	3	6.4	9	12.2	12	7.4	223	9.5
7.5- 8.4	40	5.2	29	4.4	38	13.0	2	11.8	32	9.8	5	10.6	9	12.2	10	6.2	165	7.0
8.5- 9.4	21	2.7	23	3.5	29	9.9	2	11.8	15	4.6	2	4.3	1	1.3	14	8.6	107	4.6
9.5-10.4	15	2.0	12	1.8	17	5.8	–	—	17	5.2	4	8.5	3	4.1	8	4.9	76	3.2
10.5-11.4	10	1.3	4	.6	7	2.4	–	—	9	2.8	3	6.4	3	4.1	7	4.3	43	1.8
11.5-12.4	5	.7	6	.9	5	1.7	–	—	5	1.5	1	2.1	2	2.7	2	1.2	26	1.1
12.5-13.4	2	.3	2	.3	4	1.4	–	—	5	1.5	1	2.1	1	1.3	8	4.9	23	1.0
13.5-14.4	1	.1	2	.3	2	.7	–	—	2	.6	–	—	1	1.3	8	4.9	16	.7
14.5-15.4	1	.1	–	.0	–	.0	–	—	–	—	–	—	–	—	1	.6	2	.1
15.5-16.4	–	.0	1	.2	–	.0	1	5.8	1	.3	–	—	–	—	–	—	3	.2
16.5-17.4	–	.0	–	.0	–	.0	–	—	–	—	–	—	–	—	–	—	–	—
Total	766	100.0	663	100.0	292	100.0	17	100.0	326	100.0	47	100.0	74	100.0	162	100.0	2347	100.0

Appendix Table 3. Number and Proportion of Purchased Cows that Were Removed from New Hampshire Dairy Herd Improvement Association Herds, by Age and Reason for Removal, 1952-54

Age at Disposal (Years)	Dairy Purposes		Low Production		Udder Trouble		Brucellosis		Sterility		Accidents		Death		Other Reasons		All Reasons	
	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.
1.5- 2.4	12	6.8	5	2.5	3	2.8	–	—	—	—	–	—	–	—	1	1.4	21	2.9
2.5- 3.4	25	14.2	26	13.2	6	5.6	1	10	11	9.0	2	11.9	4	14.3	7	9.6	82	11.2
3.5- 4.4	30	16.9	29	14.7	14	13.1	1	10	11	9.0	1	5.9	5	17.9	4	5.5	95	13.0
4.5- 5.4	30	16.9	38	19.4	10	9.3	2	20	12	9.8	1	5.9	2	7.1	4	5.5	99	13.5
5.5- 6.4	23	13.0	28	14.2	9	8.4	1	10	15	12.3	3	17.5	3	10.7	8	10.9	90	12.3
6.5- 7.4	12	6.8	18	9.1	11	10.3	2	20	19	15.7	1	5.9	3	10.7	7	9.6	73	10.0
7.5- 8.4	14	7.9	19	9.6	15	14.0	1	10	15	12.3	2	11.9	4	14.3	4	5.5	74	10.1
8.5- 9.4	17	9.6	10	5.1	10	9.3	1	10	11	9.0	3	17.5	3	10.7	12	16.5	67	9.2
9.5-10.4	3	1.7	9	4.6	13	12.1	–	—	7	5.7	2	11.9	–	—	8	10.9	42	5.7
10.5-11.4	5	2.8	7	3.6	5	4.8	–	—	6	4.9	1	5.9	2	7.1	2	2.7	28	3.8
11.5-12.4	2	1.1	5	2.5	3	2.8	–	—	9	7.4	–	—	–	—	8	10.9	27	3.7
12.5-13.4	4	2.3	–	—	2	1.9	1	10	1	.8	–	—	1	3.6	2	2.7	12	1.6
13.5-14.4	–	—	–	—	6	5.6	–	—		—	1	5.9	1	3.6	3	4.1	10	1.4
14.5-15.4	–	—	3	1.5	–	—	–	—	1	3.3	–	—	–	—	1	1.4	8	1.1
15.5-16.4	–	—	–	—	–	—	–	—	—	—	–	—	–	—	1	1.4	1	.1
16.5-17.4	–	—	–	—	–	—	–	—	1	.8	–	—	–	—	1	1.4	2	.3
Total	177	100.0	197	100.0	107	100.0	10	100.0	122	100.0	17	100.0	28	100.0	73	100.0	731	100.0

Appendix Table 4. Number and Proportion of Raised Cows that Were Removed from New Hampshire Dairy Herd Improvement Association Herds, by Length of Herd Life and Reason for Removal, 1952-54

Years in Herd	Dairy Purposes		Low Production		Udder Trouble		Brucellosis		Sterility		Accidents		Death		Other Reasons		All Reasons	
	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.
0.0- 0.4	35	4.6	37	5.6	11	3.8	–	—	2	.6	2	4.3	6	9.1	8	4.9	101	4.3
0.5- 1.4	197	25.7	191	28.8	39	13.5	2	11.8	49	15.0	10	21.3	7	9.5	22	13.6	517	22.0
1.5- 2.4	161	21.0	153	23.1	41	14.0	5	29.3	68	20.9	4	8.5	10	13.5	22	13.6	464	19.8
2.5- 3.4	138	18.0	110	16.6	37	12.7	–	—	61	18.7	9	19.1	15	20.4	27	16.7	397	16.9
3.5- 4.4	84	11.0	56	8.5	40	13.7	2	11.8	37	11.4	5	10.6	10	13.5	11	6.8	245	10.5
4.5- 5.4	61	8.0	44	6.6	40	13.7	4	23.5	35	11.1	3	6.4	8	10.8	9	5.6	205	8.7
5.5- 6.4	39	5.1	30	4.5	34	11.6	2	11.8	24	7.4	5	10.6	8	10.8	14	8.6	156	6.6
6.5- 7.4	18	2.3	20	3.0	20	6.8	1	5.9	18	.5	2	4.3	1	1.3	10	6.2	90	3.8
7.5- 8.4	16	2.1	10	1.5	15	5.1	–	—	13	4.0	5	10.6	3	4.1	7	4.3	69	2.9
8.5- 9.4	7	.9	3	.5	5	1.7	–	—	7	2.1	–	—	3	4.1	7	4.3	32	1.4
9.5-10.4	6	.8	6	.9	5	1.7	–	—	7	2.1	2	4.3	1	1.3	6	3.7	33	1.4
10.5-11.4	2	.3	–	—	4	1.4	–	—	2	.6	–	—	1	1.3	9	5.6	18	.8
11.5-12.4	1	.1	2	.3	1	.3	–	—	1	.3	–	—	1	1.3	7	4.3	13	.6
12.5-13.4	1	.1	1	.2	–	—	1	5.9	–	—	–	—	–	—	2	1.2	5	.2
13.5-14.4	–	—	–	—	–	—	–	—	1	.3	–	—	–	—	1	.6	2	.1
Total	766	100.0	663	100.0	292	100.0	17	100.0	326	100.0	47	100.0	74	100.0	162	100.0	2347	100.0

Appendix Table 5. Number and Proportion of Purchased Cows that Were Removed from New Hampshire Dairy Herd Improvement Association Herds, by Length of Herd Life and Reason for Removal, 1952-54

Years in Herd	Dairy Purposes		Low Production		Udder Trouble		Brucellosis		Sterility		Accidents		Death		Other Reasons		All Reasons	
	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.
0.0- 0.4	21	11.8	7	3.6	8	7.5	–	—	1	.8	1	5.9	3	10.7	3	4.1	44	6.0
0.5- 1.4	45	25.4	83	31.9	23	21.5	3	30.0	22	18.0	5	29.4	5	17.8	14	19.1	180	24.6
1.5- 2.4	43	24.3	41	20.8	14	13.1	2	20.0	25	20.5	2	11.8	3	10.7	10	13.7	140	19.2
2.5- 3.4	37	20.9	31	15.7	15	14.0	–	—	18	14.8	2	11.8	9	32.1	7	9.6	119	16.3
3.5- 4.4	11	6.2	14	7.1	10	9.3	–	—	14	11.5	2	11.8	1	3.6	10	13.7	62	8.5
4.5- 5.4	8	4.5	11	5.6	14	13.1	4	40.0	18	14.8	1	5.9	1	3.6	3	4.1	60	8.2
5.5- 6.4	3	1.7	12	6.1	6	5.6	–	—	9	7.4	3	17.5	2	7.1	6	8.2	41	5.6
6.5- 7.4	4	2.3	7	3.6	7	6.5	1	10.0	6	4.9	1	5.9	1	3.6	9	12.3	36	4.9
7.5- 8.4	3	1.7	7	3.6	5	4.8	–	—	3	2.5	–	—	1	3.6	7	9.6	26	3.6
8.5- 9.4	–	—	3	1.5	3	2.8	–	—	2	1.6	–	—	–	—	–	—	8	1.1
9.5-10.4	1	.6	–	—	–	—	–	—	2	1.6	–	—	–	—	1	1.4	4	.5
10.5-11.4	1	.6	–	—	1	.9	–	—	1	.8	–	—	1	3.6	1	1.4	5	.7
11.5-12.4	–	—	1	.5	1	.9	–	—	1	.8	–	—	1	3.6	1	1.4	5	.7
12.5-13.4	–	—	–	—	–	—	–	—	–	—	–	—	–	—	1	1.4	1	.1
Total	177	100.0	197	100.0	107	100.0	10	100.0	122	100.0	17	100.0	28	100.0	73	100.0	731	100.0

Appendix Table 6. Relation of Age at Disposal of Cows to Frequency of Various Reasons for Removal of Dairy Cows from Herds in Dairy Herd Improvement Associations, New Hampshire and Other States

Age at Disposal (Years)	Total Cows in Sample		Percentage of Total Cows Removed Because of —							
			Dairy Purposes	Low Production	Udder Trouble	Brucellosis	Sterility	Accidents	Death	Other Reasons
	No.	Pct.	Percent							
New Hampshire, 1952-54										
1.5- 2.4	107	3.5	4.1	4.4	3.0	—	0.2	3.1	3.9	4.7
2.5- 3.4	531	17.3	21.0	22.2	10.0	11.1	12.1	15.6	8.8	11.5
3.5- 4.4	559	18.2	20.6	22.6	12.8	14.8	15.3	9.4	16.7	11.1
4.5- 5.4	490	15.9	18.5	17.1	13.0	14.8	14.3	12.5	14.7	11.1
5.5- 6.4	363	11.8	12.4	10.3	11.0	11.1	13.6	14.1	13.7	11.1
6.5- 7.4	296	9.6	8.7	8.1	11.0	18.6	13.4	6.2	11.8	8.0
7.5- 8.4	239	7.8	5.7	5.6	13.3	11.1	10.5	10.9	12.7	5.9
8.5- 9.4	174	5.7	4.0	3.8	9.8	11.1	5.8	7.8	3.9	11.1
9.5-10.4	118	3.8	1.9	2.5	7.5	—	5.4	9.4	2.9	6.8
10.5-11.4	71	2.3	1.6	1.3	3.0	—	3.3	6.2	4.9	3.8
11.5-12.4	53	1.7	0.7	1.3	2.0	—	3.1	1.6	2.0	4.2
12.5-13.4	35	1.1	0.6	0.2	1.8	3.7	1.3	1.6	2.0	4.2
13.5-14.4	26	0.8	0.1	0.2	1.8	—	0.4	1.6	2.0	4.7
14.5-15.4	10	0.3	0.1	0.3	—	—	0.9	—	—	0.9
15.5+	6	0.2	—	0.1	—	3.7	0.4	—	—	0.9
All ages	3078	100.0	30.6	27.9	13.0	0.9	14.6	2.1	3.3	7.6
Kansas 1950-54[1]										
2- 3	891	7.5	11.8	7.0	3.5	2.9	2.5	8.4	6.8	6.8
3- 4	1,792	15.1	20.3	16.7	8.0	14.3	10.5	18.2	13.2	8.3
4- 5	2,210	18.6	23.7	21.1	13.6	16.4	15.4	17.8	14.2	8.9
5- 6	2,172	18.2	17.4	20.3	18.3	17.1	18.6	15.6	23.4	11.2
6- 7	1,838	15.4	13.2	16.1	20.1	18.7	18.2	14.7	14.8	12.1
7- 8	967	8.1	5.2	8.6	13.6	12.8	9.6	5.8	8.7	6.2
8- 9	753	6.3	4.4	5.0	10.3	9.3	10.8	6.2	8.4	6.1
9-10	375	3.1	2.2	2.0	4.3	0.7	5.2	2.2	3.1	6.9
10+	915	7.7	1.8	3.2	8.3	7.8	9.2	11.1	7.4	33.5
All ages	11,913	100.0	32.3	26.2	14.0	1.0	6.8	1.9	6.3	11.5
Indiana 1950[2]										
2- 4	580	24.2	28.7	22.7	13.2	32.8	18.2	24.5	—	24.6
4- 6	724	30.3	34.2	30.3	29.4	27.6	30.3	33.7	—	21.9
6- 8	544	22.7	21.4	24.7	29.4	21.1	18.2	21.4	—	18.5
8-11	413	17.2	12.3	17.1	23.1	15.5	23.0	17.3	—	21.9
11-15	134	5.6	3.4	5.2	4.9	3.0	10.3	3.1	—	13.1
All ages	2,395	100.0	27.1	30.3	11.0	9.7	6.9	4.1	—	10.9

[1] R. Bonewitz, Dairy News Letter, Kansas State Cooperative Extension Service (Monthly Mimeograph), 1950-54.

[2] G. A. Williams, *Why Cows Leave Home*, Indiana Cooperative Extension Service (Mimeograph), 1950.

Appendix Table 7. Sex Ratios Among Dairy Calves

Citation	Calves	Ratio of Males to Females When Females Equal 100	Percentage Male Births Are of Total
	Number		Percent
Davis[1]	2,428	106	51.48
Gilmore[2]	197,936	104	51.12
Gowen[3]	3,559	102	50.50
Hilder[4]	3,442	113	53.08
Hull[5]	1,060	114	53.30
Ingels[6]	1,347	107	51.88
Knott[7]	2,824	104	51.02
Frick[8]	1,102	102	50.63
Total or weighted average	213,698	105	51.2

[1] H. P. Davis, *Dairy Calf Births and Disposals*, Nebr. Agr. Sta. Bull. 411, 1952.

[2] L. A. Gilmore, *Dairy Cattle Breeding*, J. B. Lippincott Co., pp. 105-108, 1952.

[3] J. W. Gowen, "On the Sex Ratio in Cattle," Jour. of Heredity, Vol. 33, 1942.

[4] R. A. Hilder, M. H. Fohrman and R. R. Graves, *Relation of Various Factors to the Breeding Efficiency of Dairy Animals and to the Sex Ratio of the Offspring*, Jour. Dairy Sci., Vol. 27:981-992, 1944.

[5] F. E. Hull, W. W. Dimmock, F. Ely and H. B. Morrison, *Reproduction Efficiency in Dairy Cattle*, Ky. Agr. Exp. Sta. Bull. 402, 1940.

[6] J. Ingels and C. Y. Cannon, "The Mortality of Calves in the Iowa State College Dairy Herd," American Soc. Animal Production, Proceedings, 1936.

[7] J. C. Knott, "A Study of the Gestation Period of Holstein-Friesian Cows," Jour. Dairy Sci., Vol. 15; 87-98, 1932.

[8] The records of births for the University of New Hampshire dairy herd were summarized for the period 1942 through 1954 by G. E. Frick.

Appendix Table 8. Proportion of Twin Births Among Births of Dairy Cattle

Citation	Births	Twin Births	Percentage Twin Births Are of Total
	Number	Number	Percent
Arnold[1]	911	18	2.0
Davis[2]	2,362	66	2.8
Knott[3]	2,910	86	3.0
Lamb[4]	873	27	3.1
Lush[5]	531	22	4.1
Miller[6]	689	21	3.0
Miller[7]	1,165	20	1.7
Frick[8]	544	34	6.2
Total or weighted average	9,985	294	2.9

[1] P. T. Dix Arnold and R. B. Becker, *Dairy Calves, Their Development and Survival*, Fla. Agr. Exp. Sta. Bul. 529, 1953.

[2] H. P. Davis, *Dairy Calf Births and Disposals*, Nebr. Agr. Exp. Sta. Bul. 411, 1952.

[3] J. C. Knott, "A Study of the Gestation Period of Holstein-Friesian Cows," Journal Dairy Sci. 15:87-98, 1932.

[4] L. W. Lamb, *Multiple Births in Dairy Cattle*, Mich. Agr. Exp. Sta. Quart. Bul. 17:185-189, May, 1935.

[5] C. W. Lush, "Inheritance of Twinning in A Herd of Holstein-Friesian Cattle," Jour. Hered. 16:273-279, 1925.

[6] F. W. Miller, R. R. Graves and M. H. Fohrman, "Management and Breeding Data on a Dairy Herd in Which Bang's Disease (Infectious Abortion) Was Eradicated by Segregation," Jour. Dairy Sci. 20:537-550, 1937.

[7] K. Miller and L. Gilmore, "Calf Mortality, Sex Ratio and Incidence of Twins in Two University of Minnesota Herds," Jour. Dairy Sci. 32:706-707, 1949.

[8] The records of births for the University of New Hampshire dairy herd was summarized for the period 1942 through 1954 by G. E. Frick.

Appendix Table 9. Yields of Pasture per Acre by Months and Total in Cow Days and Tons of Hay Equivalent Grazed or Harvested Annually[1]

Type and Date of Treatment or Mowing	Yield per Acre								
	Cow Days							Hay Equivalent	
	May	June	July	Aug.	Sept.	Oct.	Total	Grazed	Harvested
	Days	Days	Days	Days	Days	Days	Days	Tons	Tons
PERMANENT									
(No brush and few trees)									
1. Not fertilized	10	8	5	3	3	1	30	0.5	0
2. Lime and super	18	13	8	4	5	2	50	0.8	0
3. Lime, super and potash	27	20	10	7	7	4	75	1.1	0
4. Lime and complete fertilizer	40	28	15	10	11	6	110	1.6	0
LADINO-GRASS									
5. Grazed all season	50	47	31	19	19	7	173	2.6	0
6. June 1	—	47	31	19	19	7	123	1.8	0.9
7. June 15	—	23	31	19	19	7	99	1.5	1.4
8. June 30	—	—	31	19	19	7	76	1.1	1.9
9. June 1, 30	—	—	31	19	19	7	76	1.1	2.0
10. June 15, July 15	—	—	15	19	19	7	60	0.9	2.2
11. June 30, Aug. 15	—	—	—	9	19	7	35	0.5	2.7
12 June 1, 30, July 30	—	—	—	19	19	7	45	0.7	2.6
13. June 1, July 15, Aug. 15	—	—	—	9	19	7	35	0.5	2.8
GRASS									
(Less than 10% legumes)									
14. Grazed all season	40	28	15	9	10	5	107	1.6	0
15. June 1	—	28	15	9	10	5	67	1.0	0.7
16. June 15	—	14	15	9	10	5	53	0.8	1.0
17. June 30	—	—	15	9	10	5	39	0.6	1.3
18. July 15	—	—	7	9	10	5	31	0.5	1.5
19. July 30	—	—	—	9	10	5	24	0.4	1.6
20. Aug. 15	—	—	—	4	10	5	19	0.3	1.7
21. Aug. 30	—	—	—	—	10	5	15	0.2	1.8
22. June 1, July 15	—	—	7	9	10	5	31	0.5	1.6
23. June 15, July 30	—	—	—	9	10	5	24	0.4	1.8
24. June 30, Aug. 15	—	—	—	4	10	5	19	0.3	1.9
SMALL GRAINS									
25. Oats and ladino (April)[2]	—	40	40	(15)	(5)	—	100	1.5	0
26. Oats and ladino (May)	—	20	40	—	(20)	—	80	1.2	0
27. Rye and ladino (Oct.-Mar.)	60	—	(25)	(15)	(5)	—	105	1.6	0
28. Rye (Sept. 1)	—	—	—	—	—	16	16	0.2	0
29. Barley or oats (July 1)									
30. Barley or oats (Aug. 1)	—	—	—	—	25	15	40	0.6	0
OTHER									
31. Millet or sudan (June 1)	—	—	40	60	20	—	120	1.8	0
32. Millet or sudan (July 1)									

[1] A cow day is assumed to be equivalent to about 27 pounds of dry matter or 30 pounds of hay equivalent. On good to excellent pastures, consumption per cow per day for various sized animals would be: Large cow, 1 cow day; medium-sized cow, 0.8 cow day; small-sized cow 0.7 cow day.

[2] Parentheses indicate date when grain was seeded and production of the Ladino seeding as contrasted with the grain crop.

Appendix Table 10. Pasture Production and Requirements by Livestock[1]

Type			Acres	Kind of animals pastured			Pasture rating	Cow days					
Perm.	Rot.	Other		Cows	Y. S.	Both		May	June	July	Aug.	Sept.	Oct.
Total cow-days of pasture available on farm													
Total cow-days required for whole herd													
Cow-days above or below requirements for each month													

[1] Sample of schedule used in study to determine seasonal pasture yields and requirements.

Appendix Table 11. Zone Prices for 3.7 Percent Milk, Boston Milkshed, May, 1955[1]

Zone	Distance from Boston	Class I price per cwt.	Class II price per cwt.[2]	Blended price per cwt. payable to producers
	Miles	Dollars	Dollars	Dollars
For milk delivered to city plants:		5.07	3.202	
1	0- 40			4.51
2	41- 80			4.28
3	81 and over			4.05
For milk delivered to country plants:				
6	51- 60	4.685	2.861	3.665
12	111-120	4.640	2.847	3.620
13	121-130	4.640	2.845	3.620
14	131-140	4.630	2.842	3.610
15	141-150	4.605	2.837	3.585
16	151-160	4.590	2.834	3.570
17	161-170	4.590	2.833	3.570
18	171-180	4.565	2.827	3.545
19	181-190	4.565	2.825	3.545
20	191-200	4.550	2.822	3.530
21	201-210	4.550	2.821	3.530
22	211-220	4.510	2.815	3.490
23	221-230	4.505	2.814	3.485
24	231-240	4.495	2.812	3.475
25	241-250	4.495	2.812	3.475
26	251-260	4.485	2.809	3.465
27	261-270	4.480	2.808	3.460
28	271-280	4.475	2.806	3.455
29	281-290	4.465	2.805	3.445
36	351-360	4.400	2.791	3.380
	391 and over	4.395	2.786	3.375

[1] Adapted from monthly price announcement issued by MARKET ADMINISTRATOR — GREATER BOSTON MARKETING AREA, 230 Congress Street, Boston 10, Mass. The butterfat differential to all producers for each 1/10 of 1% variation from 3.7% test is $ .072.

[2] Adjustment per pound of butterfat made into butter or cheese is $ .0027.

Appendix Table 12. Production and Utilization of Forage on a Typical Small Dairy Farm on Which All Required Dairy Herd Replacements are Raised, Price Situation II

Crop	Acreage	Production of Hay Equivalent	Utilization of Hay Equivalent by — Either Young Stock or Milking Cows: Grazed Only	Either Young Stock or Milking Cows: Harvested or Grazed	Only Young Stock or Dry Cows: Grazed Only	Only Young Stock or Dry Cows: Harvested or Grazed
	Acres	Tons	Tons	Tons	Tons	Tons
			Zone Mileage 0-40			
Hay-pasture	36	86	—	86	—	—
New seeding	9	20	—	20	—	—
Rotation pasture	14	32	32	—	—	—
Permanent pasture	45	36	26	—	10	—
Total	104	174	58	106	10	—
			Zone Mileage 41-80			
Hay-pasture	37	89	—	89	—	—
New seeding	9	20	—	20	—	—
Rotation pasture	14	32	32	—	—	—
Permanent pasture	45	36	26	—	10	—
Total	105	177	58	109	10	—
			Zone Mileage 81-120			
Hay-pasture	38	91	—	91	—	—
New seeding	10	22	—	22	—	—
Rotation pasture	14	32	32	—	—	—
Permanent pasture	45	36	26	—	10	—
Total	107	181	58	113	10	—
			Zone Mileage 121-160			
Hay-pasture	38	91	—	91	—	—
New seeding	10	22	—	22	—	—
Rotation pasture	14	32	32	—	—	—
Permanent pasture	45	36	26	—	10	—
Total	107	181	58	113	10	—
			Zone Mileage 161-200			
Hay-pasture	39	94	—	94	—	—
New seeding	10	22	—	22	—	—
Rotation pasture	14	32	32	—	—	—
Permanent pasture	45	36	26	—	10	—
Total	108	184	58	116	10	—

Appendix Table 13. Size and Composition of Herd, and Resources Unused or Sold for a Dairy Farm with Flexible Farm Resources that Shifts from 35 Cows and Raised Replacements to 40 Cows and Purchased Replacements, Price Situation I

Milk Zone Mileage and Alternative Farm Plan	Cows in Herd			Annual Replacements to Herd		Unused Equivalents				Hay Equivalent Sold
						Stanchion Equivalents				
	Raised	Purchased	Total	Raised	Purchased	Cows or Young Stock	Young Stock Only	Man-hours	Pasture as Hay Equivalent	
	Number	Number	Number	Number	Number	Number	Number	Number	Tons	Tons
0- 40 miles										
35 cows	35	0	35	10	0	0	0	0	0	0
40 cows	0	40	40	0	12	2	0	0	20	20
41- 80 miles										
35 cows									0	0
40 cows				No change					20	20
81-120 miles										
35 cows									0	0
40 cows				No change					19	19
121-160 miles										
35 cows									0	0
40 cows				No change					18	18
161-200 miles										
35 cows									0	0
40 cows				No change					18	18

Appendix Table 14. Additional Net Farm Income Possible on Dairy Farms with Flexible Farm Resources by Shifting from 35 Cows and Raised Replacements to 40 Cows and Purchased Replacements, Price Situation I

Milk Zone Mileage	Price of Milk per Hundredweight	Additional Net Farm Income by Years After Adjustment					
	Base Year	1	2	3	4	5 or more	Total for Years 1-4
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Alternative A — Sell young stock under 18 months of age at beginning of year[1]							
0- 40	6.10	0	2,391	916	916	916	Same	5,139
41- 80	5.75	0	2,305	830	830	830	Same	4,795
81-120	5.27	0	2,133	658	658	658	Same	4,107
121-160	4.93	0	1,998	523	523	523	Same	3,567
161-200	4.88	0	1,984	508	508	508	Same	3,508
Alternative B — Raise all young stock on hand at end of base year							
0- 40	6.10	0	774	2,259	159	916	Same	4,108
41- 80	5.75	0	754	2,206	73	830	Same	3,863
81-120	5.27	0	724	2,119	—99	658	Same	3,402
121-160	4.93	0	699	2,026	—234	523	Same	3,014
161-200	4.88	0	696	2,015	—249	508	Same	2,970

Appendix Table 15. Net Effect of Changes in the Price of Milk on Additional Net Farm Income Possible on Dairy Farms with Flexible Farm Resources by Shifting from Raising to Buying Replacements for Farms of Various Sizes, Price Situation II[1]

Price of Milk per Hundredweight[2]	Change in Net Farm Income: Number of Milking Cows in Herd					
	11-17	18-24	25-31	32-38	39-45	46-52
Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
0.50	—40	—55	—70	—95	—105	—115
1.00	30	50	65	80	100	120
1.50	100	150	200	250	300	355
2.00	170	255	340	420	500	590
2.50	235	355	475	595	705	830
3.00	300	455	610	765	910	1,070
3.50	370	560	745	935	1,120	1,305
4.00	440	660	880	1,105	1,320	1,540
4.50	510	760	1,020	1,275	1,520	1,780
5.00	580	860	1,155	1,445	1,725	2,015
5.50	645	965	1,290	1,615	1,930	2,250
6.00	715	1,065	1,420	1,785	2,130	2,485
6.50	780	1,165	1,555	1,955	2,330	2,720

[1] All prices paid and received, except those for milk, stay at levels consistent with the assumptions of price situation II.

[2] Break-even price about $0.75 per hundredweight.

Appendix Table 16. Net Effect of Changes in the Price of Replacements on Additional Net Farm Income Possible on Dairy Farms with Flexible Farm Resources by Shifting from Raising to Buying Replacements for Farms of Various Sizes, Price Situation II[1]

Price of Replacements[2]	Change in Net Farm Income: Number of Milking Cows in Herd					
	11-14	18-24	25-31	32-38	39-45	46-52
Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
100	980	1,460	1,950	2,460	2,940	3,420
150	750	1,115	1,490	1,880	2,240	2,620
200	515	770	1,030	1,300	1,550	1,810
250	280	420	570	720	850	1,000
300	55	80	110	140	170	200
350	—180	—260	—350	—440	—520	—600
400	—410	—610	—810	—1,010	—1,220	—1,410

[1] All prices paid and received, except those for replacements, stay at levels consistent with the assumptions of price situation II with milk priced at the level of the 0 to 10 mile zone.

[2] Break-even price about $312 per replacement.

Appendix Table 17. Net Effect of Changes in the Price of Cull Cows and Calves on Additional Net Farm Income Possible on Dairy Farms with Flexible Farm Resources by Shifting from Raising to Buying Replacements for Farms of Various Sizes, Price Situation II[1]

Price of —		Change in Net Farm Income: Number of Milking Cows in Herd					
Cull Cows	Veal Calves	11-17	18-24	25-31	32-38	39-45	46-52
Dollars		Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
5.00	10.00	555	830	1,110	1,400	1,670	1,945
10.00	15.75	625	935	1,240	1,555	1,860	2,170
15.00	21.25	690	1,030	1,370	1,715	2,050	2,390
20.00	26.75	760	1,130	1,500	1,870	2,240	2,615
25.00	32.50	825	1,230	1,630	2,030	2,430	2,835

[1] All prices paid and received except those for beef and veal stay at levels consistent with the assumptions of price situation II.

Other Bulletins in the Series on Production Efficiency on New England Dairy Farms

I. *A Preliminary Appraisal of Cost Reduction Opportunities*, I. F. Fellows, G. E. Frick, and S. B. Weeks. Storrs (Connecticut) Agricultural Experiment Station Bulletin 283, 1952.

II. *Economics of Scale in Dairying — An Exploration in Farm Management Research Methodology*, I. F. Fellows, G. E. Frick, and S. B. Weeks. Storrs (Connecticut) Agricultural Experiment Station Bulletin 285, 1952.

III. *An Economic Evaluation of the Barn-finishing Method of Harvesting Hay*, V. E. Ross and I. F. Fellows. Storrs (Connecticut) Agricultural Experiment Station Bulletin 277, 1951.

IV. *Adjustments in the Organization of Machinery and Equipment*, G. E. Frick, S. B. Weeks, and I. F. Fellows. New Hampshire Agricultural Experiment Station Bulletin 407, 1954.